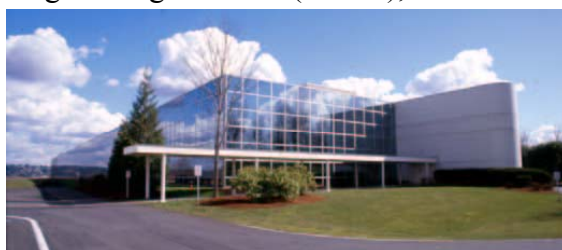


NMFS FISHERIES SCIENCE CENTERS

The National Marine Fisheries Service is a world leader in fisheries research. Each year the agency uses harvest and survey data to assess the status and trends of more than 200 major commercially-valuable fish and shellfish stocks. The NMFS Science Centers provide annual stock assessment information and management advice to support the NOAA stewardship mission for the living marine resources in their regions. These cross disciplinary efforts are undertaken in cooperation with other Federal and state agencies, international organizations, the fishing industry, and academia, and are based on long standing cooperative research agreements. In addition to these basic responsibilities, each regional Science Center has unique capabilities to focus on special research needs. The following is an overview of each of the NMFS Science Centers.

ALASKA FISHERIES SCIENCE CENTER (AFSC)

The Alaska Fisheries Science Center (AFSC) has research facilities in Alaska (Auke Bay and Kodiak Island), Washington (Seattle), and Oregon (Newport). Organizationally, the AFSC consists of the Resource Assessment and Conservation Engineering Division (RACE), the Resource Ecology and Fisheries Management Division (REFM), the National Marine Mammal Laboratory (NMML), the Auke Bay Laboratory (ABL), and other administrative units. The major shipboard platforms supporting the AFSC include the NOAA fishery survey vessels *Miller Freeman* and *John N. Cobb*, as well as chartered vessels from the fishing industry. The new fishery survey vessel, NOAA Ship *Oscar Dyson* will be commissioned in the fall of 2004. Homeport for the *Oscar Dyson* will be Kodiak, AK; the first research cruise will take place in February, 2005.



Alaska Fisheries Science Center, NOAA Western Regional Campus, Seattle, Washington.

The Center has numerous ongoing relationships with external cooperators, including state and other Federal agencies, academic institutions, foreign research institutions, the fishing industry, and resource conservation organizations.

The Center has a permanent staff of about 365 employees in support of fisheries and marine mammal research in the coastal and offshore waters of Alaska. This marine region of nearly three million square miles includes over 50% of the U.S. coastline and over 70% of the U.S. continental shelf. The region supports some of the most important commercial fisheries in the world, particularly groundfish and Pacific salmon species. It is also host to some of the world's largest populations of marine mammals and seabirds.

The Center focuses research on the following fishery resources that support major commercial fisheries off Alaska:

- Groundfish in the Bering Sea-Aleutian Islands (BSAI) region including separate catch quotas for 14 individual species or stocks and 4 species complexes. These management complexes include: shortraker/roughey rockfish, other flatfish (15 species), other rockfish (8 species, including thornyheads), and squid.
- Groundfish in the Gulf of Alaska (GOA) region including separate catch quotas for 11 individual species or stocks and 6 species complexes. The management complexes include: shortraker/roughey rockfish, deep water flatfish, shallow water flatfish, other slope rockfish, pelagic shelf rockfish, and demersal shelf rockfish.
- The remaining groundfish species managed as separate “other species” groups in the BSAI and GOA regions. These management groups include species of sculpin, skate, shark and octopuses. Eight species of skate, over 50 species of sculpins, 3 species of sharks and 4 species of octopus are occasionally caught in groundfish fisheries. Commercial and scientific interest in these species is growing, while research efforts are underway to improve our knowledge of their life history, abundance and interactions with commercial fisheries.
- Shellfish including king, tanner, snow, and hybrid crabs, several species of shrimps and sea snails.
- The five major Pacific salmon species (chinook, chum, sockeye, pink and coho) and steelhead that have supported strong traditional salmon fisheries along the entire Alaskan coastline.

In addition to research on fishery resources, the Center has recently initiated new studies that will help predict how marine resources respond to climate change, the nature and location of habitat resources required by commercially valuable fish species, and habitat interactions between fish and marine mammals. Direct research on marine mammals includes stock assessments for most marine mammal species of Alaska, as required by the MMPA and for those species also listed under the . This information, in turn, is used to assess anthropogenic impacts, including direct (e.g. incidental take) and indirect effects (e.g. competition) of fisheries on those populations.

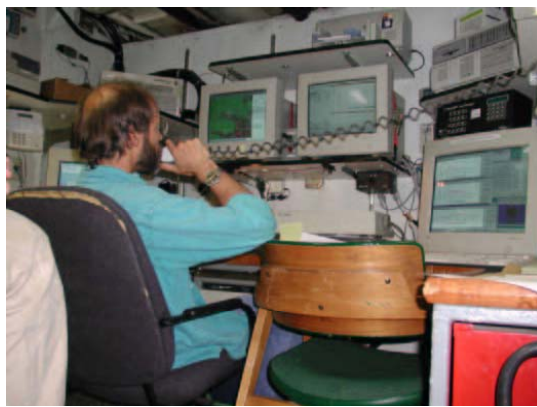
The Center also conducts research on habitat use by FMP-managed fish and invertebrates, alterations in habitat quality through human and environmental change, and an understanding of threats to habitat in Alaska. Studies involve diverse fish habitats that range from eelgrass beds to benthic substrates, and wetlands to coral and sponge communities which serve as refugia, forage grounds, or nursery areas for managed species. Perturbations include fishing, oil transportation, logging, and development, plus natural effects on fish habitat such as climate, prey distribution and nutritional quality.

Recent Accomplishments and Research Priorities for FY 2004-2009

I. Research to Support Fishery Conservation and Management

Recent Accomplishments:

Major research cruises conducted by the AFSC included: (1) the annual winter fishery acoustic surveys aboard the NOAA Ship *Miller Freeman* to estimate the biomass and distribution of pollock in Steller sea lion critical habitat around the Shumagin Islands, southeastern Bering Sea (including the Bogoslof Island area), Shelikof Straits and along the eastern side of Kodiak Island; (2) a summer longline charter vessel survey to assess the distribution and abundance of sablefish, rockfish, and other commercially important groundfish resources in the Gulf of Alaska; (3) a biennial summer bottom trawl survey of the Gulf of Alaska shelf and continental slope groundfish with three chartered fishing vessels to estimate the biomass and distribution of groundfish and to collect other biological data; (4) a pilot summer fishery acoustic survey aboard the NOAA Ship *Miller Freeman* to determine the feasibility of conducting a biennial summer Gulf of Alaska survey to estimate the distribution and abundance of pollock off bottom over the shelf; (5) a summer bottom trawl survey of eastern Bering Sea shelf with two chartered fishing vessels to estimate distribution and abundance of crab and groundfish stocks, (6) an annual bottom trawl survey for shrimp in Pavlof Bay; (7) spring, summer and fall surface trawl surveys by the NOAA Ship *John N. Cobb* to determine abundance, migration patterns, ecology, bioenergetics and carrying capacity for juvenile salmon in Southeast Alaska waters; and (8) fall surface trawl surveys of the eastern Bering Sea shelf and basin with chartered vessels to determine distribution, relative biomass, habitat, and ecology of western Alaskan salmonids.



Research scientist monitors survey trackline during an acoustic/trawl survey of pollock aboard the NOAA R/V Miller Freeman in the Gulf of Alaska.

The AFSC runs an observer program to collect information from the federally-regulated fisheries of Alaska. The observer program collected valuable data on the target fishery resource for the purpose of stock assessment. In addition, the observer program estimated the levels of direct, incidental takes of all protected species in Alaska's federally-regulated fisheries, including seabirds, prohibited species of fish, and marine mammals.

The AFSC had the lead responsibility for analyzing the population dynamics and status of most of the groundfish species managed by FMPs in the Bering Sea-Aleutians and the Gulf of Alaska regions.

The AFSC, in cooperation with the Pacific Marine Environmental Laboratory (PMEL), conducted a number of Fisheries Oceanography Coordinated Investigations (FOCI) research cruises with the support of GLOBEC (Global Ocean Ecosystem Dynamics), the Steller sea lion research program, and the North Pacific Research Board. These studies examined the

environmental and biological factors affecting the spatial distribution and relative abundance of juvenile pollock in the Gulf of Alaska and the Bering Sea, particularly with respect to their role in the ecosystem and importance as prey for Steller sea lions.

The AFSC conducted studies on salmon ocean ecology, species life histories, and historical data patterns to increase our understanding of how marine and anadromous species are affected by natural and human activities.

The AFSC, in cooperation with the NPAFC, initiated an international survey titled Bering Aleutian Salmon International Survey (BASIS), to understand the mechanisms underlying the effects of environmental variation and density-dependence on salmon carrying capacity in the Bering Sea for sustainable conservation of salmon stocks

In 2002, AFSC scientists discovered dense aggregations of deep-water corals and sponge in the Aleutian Islands area and have initiated studies of their distribution and biology.

The AFSC conducted restoration studies stemming from the Exxon Valdez oil spill in Prince William Sound, particularly those relating to the abundance and biological availability of lingering oil.

The AFSC in collaboration with Alaska Department of Fish and Game conducted a sequence of research cruises in the northeastern Bering Sea using chartered fishing vessels to determine the annual cycle in maturity and the reproductive biology of snow crab. The research was followed by two research cruises aboard two chartered vessels to design and evaluate bycatch reduction devices for the reduction of salmon bycatch in pollock midwater trawl fisheries. These cruises were conducted with the full collaboration of the pollock fishing and trawl gear industries.

The AFSC scientists with expertise in conducting bottom trawl surveys lead the development of national trawl survey standardization protocols. Under the orders of NOAA Administrator VADM Lautenbacher, the objective of this project was to develop and publish a standard set of protocols for all aspects of trawl survey preparation and execution to ensure that data meet the highest quality standards and that consistency is maintained from one survey to the next. The national report was submitted and approved on schedule.

A team of AFSC survey biologists compiled the first edition of the At-Sea Safety Manual to educate our scientists about unsafe situations and practices while working aboard chartered fishing vessels conducting trawl surveys. The team will review and update the document on an annual basis.

AFSC scientists have recently completed a major atlas of ichthyoplankton abundance and distribution patterns in the northeast Pacific Ocean and the Bering Sea ecosystems. The atlas



Sorting a catch of groundfish collected with a bottom trawl during a research cruise aboard the NOAA R/V Miller Freeman in the eastern Bering Sea.

contains detailed information on the early life stages of 103 fish taxa and will be readily available to a wide range of investigators both in print form and on-line.

The NMML conducted research to determine the status, conservation needs, and potential impacts of fishing activities on marine mammals of Alaska. Based on data collected by the Center's observer program, federally-regulated fisheries are not considered to have a direct, incidental take level of marine mammals high enough to warrant management action. However, indirect interactions between some commercial fisheries and some species of marine mammals (e.g. Steller sea lions and northern fur seals) may potentially occur. Research to resolve whether and to what extent these interactions occur has included surveys of marine mammal forage fish and the collection of detailed foraging information. The NMML worked closely with the Alaska Scientific Review Group (ASRG) to determine the status of marine mammal stocks in Alaska. The ASRG includes representatives from Alaskan universities, the Alaska Native community, and the commercial fishing industry.

The AFSC (ABL) completed radio-tagging studies on Yukon River chinook and fall chum salmon that documented spawning location, migration rates, and estimated numbers crossing the border into Canada. Genetic baseline information on salmonids was assembled to identify stocks or country of origin. AFSC scientists are key partners in Coastal Fish Habitat Restoration design, application of new aquatic habitat restoration technologies and in developing the database needed to test the effectiveness of those restoration designs.

Research Priorities, FY 2004-2009:

I.A. Biological research concerning the abundance and life history of fish stocks

The following surveys are planned by the AFSC:

- Conduct an annual summer bottom trawl survey on groundfish and crabs in the eastern Bering Sea shelf with chartered fishing vessels.
- Conduct midwater trawl-acoustic surveys to assess the off-bottom component of pollock stock in the Bering Sea every two years (2004, 2006, 2008) and the Gulf of Alaska (2005, 2007) from the NOAA Ship *Miller Freeman* and/or the new NOAA Ship *Oscar Dyson*
- Conduct the biennial eastern Bering Sea slope survey for groundfish (2004, 2006, 2008) with a chartered fishing vessel.
- Conduct the annual winter surveys on spawning pollock stocks in the southeastern Bering Sea, Bogoslof Island area (biennial schedule), Shumagin Islands, Shelokof Straits and along the east side of Kodiak Island using the NOAA Ship *Miller Freeman* and/or the new NOAA Ship *Oscar Dyson*.
- Conduct the biennial summer bottom trawl survey on groundfish in the Gulf of Alaska with chartered fishing vessels every two years (2005, 2007, 2009).

- Conduct the biennial summer bottom trawl survey on groundfish in the Aleutian Islands region with chartered fishing vessels every two years (2004, 2006, 2008).
- Conduct annual summer longline surveys on sablefish resources in the Gulf of Alaska by a chartered vessel and in the Bering Sea and Aleutian Islands on alternate years.
- Conduct annual FOCI research cruises for larval pollock, plankton productivity and ecosystem status, and juvenile pollock ecology from NOAA Ship *Miller Freeman* and/or the new NOAA Ship *Oscar Dyson* and chartered UNLOS (University-National Oceanographic Laboratory System) vessels.
- Conduct annual fall surface trawl surveys on Pacific salmon ecology in the Bering Sea using chartered fishing vessels (2003-2006).
- Conduct annual summer surface trawl surveys on Pacific salmon ecology in the Gulf of Alaska using a chartered fishing vessel (2003-2005).
- Conduct annual Southeast Coastal Monitoring (SECM) surface trawl cruises with NOAA vessel *J. N. Cobb* to study the habitat use and early marine ecology of juvenile Pacific salmon.



Deployment of a specially-developed acoustic buoy from the NOAA R/V Miller Freeman. This free-floating buoy contains a scientific acoustic system which can be used to assess local abundance of pelagic fish and observe reactions of fish to disturbance.

In addition to the above traditional baseline surveys, the AFSC has a Fishery Interaction Team that develops and implements surveys to study the interactions among the component species of the ecosystem, the environment and fisheries. The research includes:

- An annual tag release and recovery cruise for Atka mackerel in the Aleutian Islands to assess the impact of commercial fishing on the local distribution and abundance of Atka mackerel inside and outside Steller sea lion critical habitat.
- An annual Pacific cod pot survey on the Eastern Bering Sea shelf to assess the impact of commercial fishing on the local distribution and abundance of Pacific cod inside and outside Steller sea lion critical habitat.
- Surveys of seasonal, temporal and spatial variations in energy content of Steller sea lion prey.

AFSC is also planning to conduct research cruises to inter-calibrate the scientific acoustic survey systems between the NOAA Ship *Miller Freeman* and the new NOAA Ship *Oscar Dyson* t: a) ensure the standardization of the surveys over time series; b) to estimate the selectivity and

catchability of standard bottom trawl survey nets; c) to conduct experiments with trawling procedures in order to confirm or revise AFSC trawl survey standards relative to ensuring that the national trawl protocols are met; and d) to continue research on essential fish habitat determination and to measure the effects of fishing on it. During all standard surveys, biological specimens of fish and invertebrates will be collected to identify new species, estimate biological rates, study prey-predator relationships, and genetic stock structure.

The following observer programs are planned for the groundfish fisheries that occur off Alaska:

- 100% observer coverage of fishing and processing vessels longer than 125 feet.
- 100% observers coverage of most fish processing plants onshore.
- 30% observer coverage of fishing vessels that are 65-125 feet.
- 100% observer coverage (with multiple observers) of special category vessels that engage in community development quota (CDQ) and American Fisheries Act(AFA)fishing operations.

The AFSC will assess trends in Alaskan salmon populations and the environment though:

- Operation of a two-way fish weir to relate climatic changes with long-term variability in fresh water and marine survivals for seven anadromous salmonids.
- Retrospective analyses and monitoring programs focusing on the covariance between climate, ocean conditions and Alaskan salmon populations at various time and spatial scales.
- Process oriented studies on inter-annual variations in marine carrying capacity and bioenergetics of juvenile salmon including trophic interactions with predators and competitors, food habits, zooplankton prey densities and composition, and condition assessed as energy density.

The AFSC will assess the status of Alaskan groundfish stocks and document their management requirements in annual Stock Assessment and Fishery Evaluation (SAFE) documents. The SAFE documents will define estimates of stock biological production potential (MSY or proxy thereof), recommend levels of acceptable biological catch (ABC), overfishing levels, bycatch requirements, and other harvest control rules for the setting of fishery regulations. The stocks covered are:

- All Bering Sea - Aleutian Islands groundfish stocks or stock complexes that includes EBS pollock, AI pollock, Bogoslof pollock, Pacific cod, yellowfin sole, rock sole, arrowtooth flounder, flathead sole, Greenland turbot, Alaska plaice, other flatfish, Pacific ocean perch, other rockfish, other red rockfish (including shortraker, rougheye, and northern rockfish), Atka mackerel and sablefish.

- All GOA groundfish stocks or stock complexes including western central pollock, southeast pollock, Pacific cod, arrowtooth flounder, flathead sole, other flatfish (including rex sole, deepwater flatfish, and shallow water flatfish), Pacific ocean perch, northern rockfish, other slope rockfish (including shortraker, roughey rockfish), pelagic shelf rockfish, Atka mackerel and sablefish. The Alaska Department of Fish and Game will assesses the demersal shelf rockfish complex.
- King and Tanner and snow (*opilio*) crab in the eastern Bering Sea.

Due to significant conservation concerns caused by the precipitous decline of Steller sea lions, research directed at resolving the nature and extent of indirect interactions between them and commercial fisheries in Alaska will continue. In addition to the research conducted by the AFSC Fisheries Interaction, activities focusing on the Steller sealion/groundfish fisheries issue will include:

- Investigation of overlap between Steller sea lion foraging areas and commercial fishing grounds.
- Use fish bones to estimate length of prey species consumed by Steller sea lions.
- Updating fisheries analytical models to explicitly include potential causes of the Steller sea lion decline.
- Comparative surveys of forage fish abundance and distribution off Kodiak Island and Southeast Alaska.



Steller sea lion, Middleton Island, Gulf of Alaska.

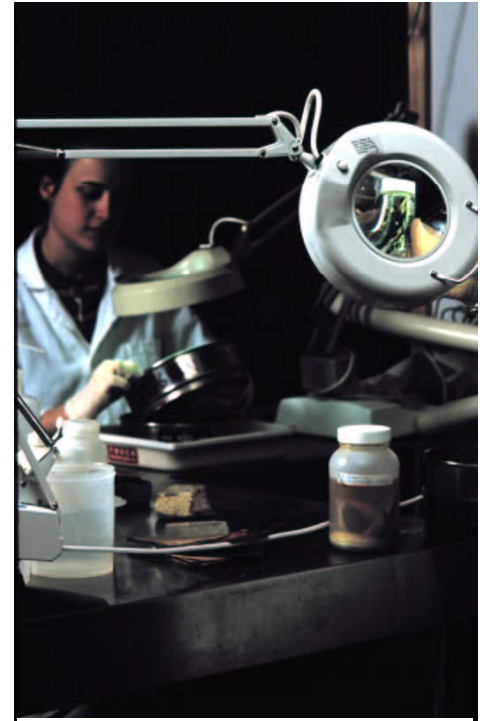
I.B. Social and economic factors affecting abundance levels

- Expand sociological and economic research and incorporate results into the fishery management process. The process will include the acquisition of data, and development and analysis of socio-economic models, that are compatible with, and can integrated with, ecosystem models.
- Conduct research on vessel over-capitalization and impacts of their fishing effort levels on fisheries.
- Compile and analyze data on harvesting and processing sector behavior.

I.C. Interdependence of fisheries or stocks of fish

- Collect and analyze stomach contents of groundfish to determine ecological linkages between species.

- Develop and maintain multi-species and ecosystem models that quantify predator-prey interactions between species.
- Collect biological specimens of spawning pollock throughout its range for genetic marker studies through DNA and other genetic techniques. Cooperation with foreign scientists is required for sampling non-U.S. waters.
- Analyze survey and observer data to determine spatial distributions of different species clusters that would indicate separation or interdependence of stocks.
- Develop genetic baseline information on salmonids to identify stocks or area of origin.
- Conduct winter acoustic surveys to estimate distribution and abundance of pollock in Steller sea lion critical habitat areas in southeast Bering Sea, Shumagin Islands, and Kodiak Island to determine dependence of sea lions on localized food supplies and assess feasibility of annual time series.
- Develop genetic baseline data for selected species of groundfish to establish stock structure and stock boundaries.
- Determine incidence of coded-wire tagged salmonids in commercial and research catches in the North Pacific Ocean and Bering Sea and report annually to Pacific States Marine Fish Commission and North Pacific Anadromous Fish Commission.
- Evaluate the importance of resident rainbow trout on the genetic and biological integrity of anadromous steelhead populations and the impacts on Evolutionary Significant Unit (ESU) determinations.



NMFS scientist investigates dietary components of Steller sea lions and other marine mammals in Alaska.

I.D. Identifying, restoring, and mapping of essential fish habitat (EFH)

- Conduct studies on the impacts of logging, urbanization, and mining on coastal salmon resources in southeast Alaska. NMFS will work with the Corps of Engineers and local organizations to restore an urban impacted salmon stream.
- Conduct restoration studies related to the Exxon Valdez oil spill in Prince William Sound. The research will build upon the results reported in the accomplishments section, including a study of the effects of oil on the biology, homing, and survival of pink salmon.

- Conduct acoustic surveys of ocean floor to characterize and identify bottom type and map the habitats of the continental shelf and slope off Alaska.
- Conduct pilot mapping of fishing grounds and essential fish habitat associated with those grounds: describe benthic habitats, community structure of the habitats, and the basic life histories of corals, sponges, and other benthic invertebrates.
- Conduct studies on the impacts of urbanization, sewage, and vessel traffic on coastal salmon resources in Alaska. NMFS will work with Federal, State, and local governments as well as local organizations to restore urban impacted salmon watersheds.
- Map seasonal and temporal shifts in the use of kelp and eelgrass habitat by nearshore fish assemblages in Southeast Alaska.

I.E. Impact of anthropogenic factors and environmental changes on fish populations

- Investigate the role of pathogens and parasites in vitality of fish, shellfish, and marine mammal populations and as bio-markers of anthropogenic and environmental change on stock health.
- Conduct Fisheries Oceanography Coordinated Investigations (FOCI): a cooperative research program with the Pacific Marine Environmental Laboratory of NOAA's Oceanic and Atmospheric Research Office to investigate the causes of variation in annual recruitment in fish stocks and investigate the ecological interactions and relationships relevant to the productivity of the ecosystem and ecosystem-based management.
- Assess effects of fishing on EFH and develop ways to minimize adverse impacts.
- Assess impacts of natural and anthropogenic factors on the production, distribution and abundance of Alaskan groundfish stocks. Products are included in contributions to the ecosystem considerations chapter of the SAFE documents, peer reviewed publications and stock assessment advice.
- Analyze the response of fish populations to changes in climate and the ecosystem.
- Develop, evaluate, and update indicators of climate effects on North Pacific stocks and ecosystems and incorporate these into predictive assessments.
- Evaluate hatchery/wild stock interactions of juvenile chum salmon in inshore and coastal marine habitats of Southeast Alaska to rebuild and maintain sustainable, economically viable fisheries.
- Conduct Ocean Carrying Capacity (OCC) investigations: a cooperative research program with the North Pacific Anadromous Fish Commission and other partners to investigate the factors affecting distribution and survival of Pacific salmon in the Gulf of Alaska and Bering Sea.

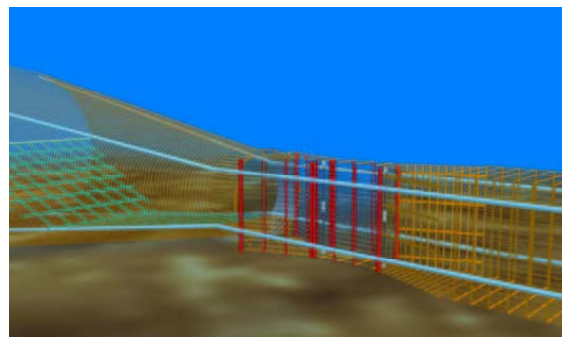
- Conduct restoration studies related to the Exxon Valdez oil spill in Prince William Sound. The research will focus on the long-term effects of lingering oil on intertidal organisms. This is part of an inter-agency study examining transfer of oil from intertidal organisms to bird and otter predators.
- Determine if remote delivery of persistent organic contaminants such as PCBs and pesticides via migratory fish or atmospheric deposition is occurring in Alaskan watersheds.

II. Conservation Engineering Research

Recent Accomplishments:

The AFSC continues to conduct research cruises and to analyze results of recent surveys to measure the direct effects of bottom trawling on seafloor habitat in eastern and central Gulf of Alaska, eastern Bering Sea, and the Aleutian Islands. Some of the major accomplishments were: (1) the assessment of changes to the seafloor caused by chronic long-term trawling in soft-bottom areas in the Gulf of Alaska; (2) the examination of possible adverse effects of bottom trawls on soft-bottom benthos in the eastern Bering Sea; (3) the evaluation of acoustic technology for seabed classification; (4) the assessment of impacts to habitat areas of particular concern (HAPC) such as gorgonian corals; (5) the documentation of the effects of trawling on hard bottom habitat in the Aleutian Islands and Gulf of Alaska; and (6) the mapping of the areas by sediment types.

The AFSC worked cooperatively with the pollock midwater fishing vessels to design and evaluate a bycatch reduction device to reduce the bycatch of salmon in their midwater trawls. With the funding support of the North Pacific Research Board, the first observations were made on the capture behavior of salmon in a midwater trawl targeting on pollock. Based on these results, fishermen working with AFSC scientists have developed and evaluated a number of possible designs in a large tow tank in eastern Canada. These designs have been refined and will be evaluated at sea late this summer on a charter vessel. The most promising design will then be used in a commercial operation to evaluate its effectiveness in reducing bycatch of both chinook and chum salmon in the eastern Bering Sea pollock fisheries under actual fishing conditions. If these trials prove effective, then the industry will likely start installing the net modifications for their 2004 fisheries



Schematic drawing of a commercial bottom trawl that has been modified to reduce bycatch of flatfish in the Alaskan fishery for Pacific cod.

The NMML worked closely with the Northwest Regional Office and the Makah tribe to develop methods for deterring the incidental mortality of harbor porpoise in salmon gill nets. The development of an acoustic pinger resulted in a significant reduction in marine mammal bycatch.

AFSC scientists carried out laboratory experiments on live fish at the Hatfield Marine Science Center in Newport, OR to determine the impact of stress from capture processes on the behavior and survival of important bycatch species in trawl and longline fisheries. This research provided insights on the key principals which control fish mortality by integrating analysis of behavioral and physiological assays and observed mortality. Recent work with sablefish and Pacific halibut have shown that environmental factors, including temperature and air exposure can interact with gear stressors to magnify mortality and susceptibility to stress and mortality. Studies related to the condition of juvenile pollock escaping through codend meshes found that juvenile pollock are a ‘fragile species’, significantly impaired and more vulnerable to predation after escapement from a simulated trawl codend.

Research Priorities, FY 2004-2009:

- Continue to conduct research to measure direct effects of bottom trawling on seafloor habitat according to a five-year research plan.
- Conduct fishing gear performance and fish behavioral studies to reduce bycatch and bycatch mortality of prohibited, undersized, or unmarketable species, and to understand performance of survey gear.
- Work with industry and the Council to develop bycatch reduction techniques.

III. Research on the Fisheries

Recent Accomplishments:

The AFSC conducted economic and social research to support fishery conservation and management actions, particularly those of the NPFMC. In terms of that research and data programs to support such research, the principal accomplishments included the following:

- Developed a report on the economic status of the Alaska groundfish fisheries and incorporated it as part of the SAFE reports for the Bering Sea/ Aleutian Islands (BSAI) and Gulf of Alaska (GOA) groundfish fisheries.
- In cooperation with NPFMC, ADF&G and PSMFC staff and industry, developed comprehensive economic data reporting requirements as part of the BSAI Crab Rationalization Program recommended by the NPFMC.
- Analyzed economic consequences of fishery management actions including bycatch management, changes to the North Pacific Groundfish Observer Program, and additional protection for Steller sea lions.
- Published research on fishing capacity and other measures of economic productivity, regional economic models, valuing recreational fisheries, subsistence hunting and fishing practices, and subsistence issues in US law.

- Completed a quantitative assessment of excess fishing capacity in federally managed fisheries off Alaska and created multi-input, multi-output parametric primal capacity models that can be estimated with existing, routinely collected data.
- Prepared both the Traditional Ecological Knowledge section of the Draft Programmatic Supplemental Environmental Impact statement (DPSEIS) for the groundfish fisheries and the Tribal Communities chapter of the NMFS Sociocultural Practitioner's Manual.
- Supported the increased use electronic logbooks to provide biological and economic data that are more complete, accurate and timely.
- Hired an anthropologist and completed field work in two Alaska fishing communities in order to develop community profiles and identify indices of the sociocultural impacts of fisheries and fishery management measures.

The AFSC completed a qualitative assessment of excess fishing capacity in federally managed fisheries off Alaska, assisted in a NMFS national effort to define and measure excess capacity, and revised the guidelines for economic analysis of fishery management actions.

Full utilization of groundfish is mandated by regulation in Alaska. The AFSC contributed to research that led to a ban on roe-stripping and the proper utilization of young fish. The research efforts now concentrate on developing and incorporating aspects of uncertainties associated with stock assessments and ecosystem interactions of the major component species to assess the status, population dynamics, and biological productivity of most of the major groundfish species managed by FMPs in the BSAI and the GOA regions. For example, the effects of variable recruitment and predation needs of marine mammals have been incorporated to provide risk analyses of different exploitation strategies on the Gulf of Alaska pollock stocks so that the stocks are properly utilized.

Research Priorities, FY 2004-2009:

III.A. Social and economic research

- Assist in implementing and improving data collection programs that support economic and social research.
- Assess the economic and social impacts of current and proposed fishery conservation and management measures and improve assessment methodologies.
- Prepare the economic status of Alaska's groundfish fisheries as part of the annual Groundfish SAFE reports.
- Assess the economic and sociocultural performance of the federally managed fisheries off Alaska and improve assessment methodologies.

III.C. Marine aquaculture

- Conduct stock-enhancement aquaculture research on chinook salmon at the AFSC's Little Port Walter Field Station to determine hatchery strategies that result in an increase contribution of Alaska-origin chinook salmon in Alaska salmon fisheries.
- Conduct parentage analysis of multi-generational hatchery chinook salmon and wild stock cohorts using DNA micro-satellites to determine relative biological and fishery contribution performance measures.
- Measure the effects of 70 years of freshwater sequestration on genetic variability, growth, survival, maturation, juvenile behavior, and adult spawning behavior on normally anadromous steelhead trout with implications for successful restoration of ESA listed stocks.
- Determine effects of different founder regimes on genetic variation in hatchery brood stocks of salmon.

IV. Information Management Research

Recent Accomplishments:

The AFSC communicates its scientific information and advice, along with the associated uncertainties, to the Councils, other management authorities, and the public. For example, survey results of the AFSC were disseminated to the user groups through the participation of experts at meetings and submission of technical reports and published papers. On a yearly basis, the AFSC publishes roughly 100 scientific papers as well as over a dozen NOAA Technical Memos and Center Processed Reports.

The AFSC has been proactive in web enabling public access to research information. Projects include:

- Development of a web enabled database of research projects conducted at over 25 institutions throughout the world investigating the cause of the decline of the western population of Steller sea lions.
- Alaska Fisheries Science Center scientists have conducted ichthyoplankton cruises in 1972 and yearly from 1977 until the present. The results are now in a web enabled database which allows users to search for cruises of interest based on region, sampling gear, and/or sampling date. The results will return a list of the cruises meeting the search criteria and will link to a synopsis of each cruise.
- Alaska Fisheries Science Center scientists and researchers gather thousands of digital images on the various scientific cruises. The AFSC has web enabled access to nearly 10,000 images through the deployment of an image management database system.

- Geographic Information Systems (GIS) play a key role in the analysis of data. The AFSC annually conducts training programs for AFSC scientists and researchers on how to use the various GIS tools available to them.
- The AFSC is the host for the National Marine Fisheries Service “Fish News” listserver. FishNews is an automated, e-mail-based newsletter that provides electronic notification of important actions, rules, policies and programs that may be of interest to the public.

The AFSC and other research units of NMFS used stock assessment workshops, peer reviews, and other fora to ensure that our information and advice are developed through an open and collaborative process. The stock assessment process of the AFSC undergoes periodic review internally and externally throughout the years.

AFSC scientists participated as scientific advisors to bilateral technical committees in various international salmon fora including the U.S.- Canada Pacific Salmon and Yukon Treaty accords and the North Pacific Anadromous Fish Commission (NPAFC).

The AFSC database for bottom trawl surveys is undergoing a major restructuring to include all the catch, haul, specimen, and effort data that are being routinely collected. The design is nearly complete and populating the new data base has begun thanks to ESDIM funding support.

The AFSC provided guidelines to assist the Councils in assessing and specifying MSY for managed fisheries. The AFSC (REFM Division) has the lead role for defining and estimating the MSY levels for all the groundfish stocks managed in the BSAI and GOA area. The information helps the NPFMC determine the relative status of the stocks to historical levels. The AFSC also has the lead role in defining and estimating the overfishing levels for each of the groundfish stocks managed in the BSAI and GOA area. These maximum fishing levels guide the NPFMC to manage exploitation of the stocks within biologically safe levels.

The AFSC (REFM) provided the technical lead role to develop objective and measurable criteria for stocks that are overfished or approaching an overfished condition. The definitions were used as uniform applications throughout NMFS. These definitions would standardize the criteria for determining depleted stocks due to fishing and other causes throughout the nation.

The AFSC provided technical expertise and analysis in environmental impact statements involving Alaska groundfish fisheries.

The AFSC is developing ecosystem-based indicators and assessments. This information is being integrated into documents provided to fishery managers in support of ecosystem-based management. Time- series data on climate, fishing, and status and trends of species and ecosystem-level characteristics are being collected from diverse sources and consolidated into a central place to facilitate integrated ecosystem assessments.

The AFSC provided the technical lead role for developing *the Marine Fisheries Stock Assessment Improvement Plan* for Alaska groundfish. Research activities include a broad

spectrum of field research and data analyses that involves other divisions within the Center and partnerships with three Universities.

The AFSC (REFM) continues to provide the technical lead to further define overfishing for uniform applications throughout NMFS. The role also extends into a National Committee tasking to establish new for listing under ESA

Research Priorities, FY 2004-2009:

- Develop processes and procedures which will enhance the communication of scientific information generated by the Alaska Fisheries Science Center with emphasis on web enabled access to its data.
- Continue to build data infrastructure and resources for easy access and data processing. The AFSC's key data bases are its survey data bases from the 1950's (or earlier) and the scientific observer data base that extends back to the foreign fishing days of the 1960s.

Continue to provide information products based on experts and technical data that support NMFS, the regional office, the Councils, international scientific commissions, and the overall research and management community.

NORTHWEST FISHERIES SCIENCE CENTER (NWFSC)

The Northwest Fisheries Science Center (NWFSC or Center) conducts research to support the management, conservation, and sustainable use of the Pacific Northwest region's anadromous and marine fishery resources and their habitats. The Center carries out its research from its Montlake Laboratory headquarters in Seattle, WA, and from five research stations in Manchester, Mukilteo, and Pasco, WA, and in Newport, and Pt. Adams, OR. The Center's more than 300 federal employees and 200 non-federal employees conduct both field and laboratory research in coastal, ocean, and estuarine environments, as well as in inland freshwater habitat that anadromous species, like salmon, use.



Northwest Fisheries Science Center's historic 1931 Montlake Laboratory, Seattle, WA.

The NWFSC has several small vessels for conducting studies. The R/V Harold Streeter serves Puget Sound while the RV Murrelet, R/V Siliqua, and the R/V Quinnat serve Columbia River Basin projects. The Center currently does not have a dedicated research vessel, but a dedicated research vessel is currently being planned. Center scientists currently rely on the NOAA R/V Miller Freeman and the McArthur II, as well as on privately chartered vessels and academic research ships to supplement its research capability and conduct critical surveys.

The Center's research brings together a number of disciplines including, fisheries science, marine biology and ecology, genetics, biochemistry, molecular biology, oceanography, and physiology. Organizationally, the Center consists of the Conservation Biology Division, the Environmental Conservation Division, the Fish Ecology Division, the Fishery Resource Analysis and Monitoring Division, and the Resource Enhancement and Utilization Technologies Division. In addition, the Center has Socioeconomics, Marine Mammal, and Science Synthesis and Coordination programs. Across these five divisions and programs, NWFSC scientists and staff conduct research in five primary areas:



NOAA R/V Miller Freeman.

- **Status of stocks**—Center scientists conduct and coordinate stock assessments for West Coast groundfish and salmon stocks in the Pacific Northwest by taking a variety of measurements, analyzing the data, and using mathematical models to draw conclusions from the results. These assessments are one tool used by managers to identify overfished and threatened stocks and set biologically sustainable harvest levels.
- **Human Caused Stress/Risks**—Center scientists conduct research to better understand how salmon, marine fish, and marine mammals react to these stresses and to quantify, assess, and minimize these risks. The Center's research provides the underpinning for management decisions.
- **Ecosystem and Climate Characteristics**—Center scientists conduct research on physical and biological processes that influence aquatic, marine, and estuarine ecosystems in the Pacific Northwest, as well as the effects of invasive species, toxic phytoplankton, climate change, and natural environmental fluctuations.
- **Recover and Rebuild Species**—Center scientists study genetic variation and conduct research on the population structure of salmon, marine fish, and killer whales. The Center also develops innovative recovery tools like captive broodstock programs to propagate salmon species, new techniques for rearing hatchery fish, and culture techniques to rear marine fish. In addition, Center scientists are directly involved in salmon recovery planning efforts on the west coast.
- **Innovation and Technology**—Center scientists are taking a lead role in developing and applying technologies, techniques, and tools to support conservation and recovery of the Pacific Northwest's living marine resources. Over the years, the Center's innovative and original research has helped establish new aquaculture endeavors, seafood processing techniques, dam passage equipment and techniques, methods to detect and evaluate harmful algal blooms, and technology to integrate and track important fisheries dependent data, as well as to identify and monitor marine and anadromous fish populations.

The Center has lead responsibility in the region to study and provide state-of-the-art scientific information on the following primary living marine resources.

- Pacific Salmon—Fifty-two populations of salmon and steelhead exist on the west coast, twenty-six of which are listed as endangered or threatened under the .
- West Coast Groundfish—The west coast groundfish fishery includes some 80 commercially fished stocks and supports millions of dollars in economic activity and many livelihoods. The Center coordinates NMFS' Groundfish Program on the west coast.
- Killer Whales—The Southern Resident killer whale populations was recently listed as depleted under the MMPA. The Center has developed a research plan to address possible causes for the killer whale decline and to gain a better understanding of the physiology, ecology, and behavior of these whales.

As part of the Center's studies of these living marine resources, Center scientist also conduct research that helps predict how marine resources respond to environmental variability and climate change, the nature and location of habitat resources required by commercially valuable fish species, and habitat interactions between fish and marine mammals.

The NWFSC develops and maintains strong collaborative partnerships with state and federal agencies, industry, environmental groups, Native American tribes, individual fishers, universities, and other research and academic institutions. The Center also provides opportunities for students in marine research, technology, and library science through cooperative research agreements with regional universities and councils.

NWFSC research supports critical management decisions. Center scientists continually strive to improve the state-of-the-art of the scientific information they provide.

Recent Accomplishments and Research Priorities for FY2004-2009

I. Research to Support Fishery Conservation and Management

Recent Accomplishments

The NWFSC developed comprehensive research plans for west coast groundfish, hatchery science, socioeconomics, watershed ecology, and Pacific salmon to ensure that all relevant scientific information is available to regional managers and policy makers. All plans were reviewed by external scientists and constituents.

The Center convened a series of program reviews using external panels of scientists to evaluate the quality and appropriateness of the Center's science in three major areas: artificial propagation, ocean and estuarine ecology, and watershed ecology and recovery planning.

The NWFSC conducted extensive assessments of west coast groundfish species and analyzed the potential for rebuilding species classified as overfished. Center scientists completed stock assessments for Pacific whiting and canary and yelloweye rockfish, updated the stock assessment for sablefish, and coordinated rebuilding analyses for widow and darkblotched rockfish.

The Center expanded its annual series of slope species surveys from Cape Flattery, WA to the Mexican border (previously surveys ended at Morro Bay, CA). The Center also expanded these surveys to include both shelf and slope trawl collections. This combined survey is designed to provide comprehensive information on the status of ecologically and economically important groundfish populations. A newly-adopted stratified random sampling scheme was implemented this year to improve the survey design and help provide baseline observations on seabed types for future development of groundfish habitat maps. These surveys provide information about distribution, relative abundance, and age structure of important groundfish populations.

Center scientists developed and implemented a new Pacific whiting acoustic survey, which was conducted jointly with Canada to improve timeliness of stock assessments for this species. In 2003, the survey was restructured to be fully cooperative and included a contingent of both U.S. and Canadian scientists along each leg of the cruise. This new biennial sampling regime will provide better tracking of the Pacific whiting population.

The NWFSC initiated a hook-and-line survey, in cooperation with sportfishing and commercial industry vessels, for bocaccio and other shelf rockfish in the Southern California Bight. This survey will improve the information base for groundfish species that are often not adequately sampled during the annual trawl survey and to augment knowledge and expertise of fisheries in this historically under-sampled region.

The Center coordinates the West Coast Observer Program. In 2002, the Center added approximately 20 observers to its Observer Program in California, Washington, and Oregon ports, bringing the total number of observers to about 40 coastwide. The Observer Program released, in 2003, the summary and analysis of the first year's observations of the trawl fleet. The data are the most up-to-date and accurate groundfish catch information on the west coast. The Center also organized and hosted a workshop to explore options to enable the agency to more effectively deploy observers on small boats.

Center scientists chaired a Biological Review Team to review the status of the Southern Resident killer whale population. The team evaluated whether these whales were a distinct population of the global killer whale species, why the whale population has been declining, and estimated the risk of extinction of this stock.

The Center co-hosted with the Washington Department of Fish and Wildlife two killer whale-related workshops, one on vessel interaction and the other on prey, with participation from local, regional, national, and international experts to identify the most important research questions to improve our understanding of the low survival and reproductive success of Southern Resident killer whales.

The NWFSC created a Southern Resident killer whale research plan and is implementing research projects with local, regional, national, and international experts to address possible causes for Southern Resident killer whale decline and to gain a better understanding of their physiology, ecology, and behavior.

Northwest and Southwest Fisheries Science Center scientists updated the status reviews of all currently listed salmon and steelhead evolutionarily significant units (ESUs), as well as one candidate species population, to consider new data that had accumulated since the mid-1990s and to address issues raised in recent court cases regarding the consideration of hatchery and resident fish populations in listing determinations.

Center scientists continued to chair three salmon Technical Recovery Teams (TRTs): Puget Sound, Lower Columbia River and Willamette River, and Interior Columbia River Basin, and co-chaired the Oregon and Northern California Coast TRT. TRTs are describing the biological conditions that are necessary for recovery of listed populations and are providing technical support to policy makers to help evaluate alternative strategies for meeting recovery goals. The Center developed the original TRT concept, purpose, and goals.

The NWFSC developed a Cumulative Risk Initiative (CRI) to assess salmonid population trends and the impact of various actions across the entire salmonid life cycle. This framework has enabled scientists to evaluate how actions in different portions of the salmon life cycle may improve survival, reduce risks, and foster recovery.

The Center conducted critical surveys to assess juvenile salmon abundance, distribution, growth, and health in estuarine environments and to determine how changes in ocean conditions affect juvenile salmon.

The NWFSC conducted studies to investigate prespawn mortality in adult coho salmon from urban streams and co-hosted, with Seattle Public Utility District, a public meeting to discuss preliminary results and develop a more comprehensive and collaborative research effort.

In 2002, the NWFSC spearheaded a multi-million dollar research project to study the ecology and oceanography of *Pseudo-nitzschia*, the algae that produce the neurotoxin domoic acid. The first two of six cruises were conducted in summer 2003 to measure the physical, chemical, and physiological conditions under which the algae produce the toxin domoic acid and when the toxin is released into the environment.

Center scientists continued critical studies to evaluate the potential delayed effects of juvenile salmon passage through the Columbia River Hydropower System. They found that the salmon smolts' passage history through the Columbia River was related to differences in their survival and immune system function.

NWFSC scientists conducted a large study using radiotelemetry and PIT-tag technology to evaluate total project survival, route-specific survival, and fish passage behavior at Ice Harbor Dam for yearling and subyearling chinook salmon.

The Center established a new initiative on the science for ecosystem-based management to provide scientific advice on the ecological processes necessary to sustain ecosystem composition, structure, and function in the environments in which fish and fisheries exist.

Newport scientists co-led an expedition to study and compare Astoria Canyon, a submarine canyon off the mouth of the Columbia River, with Heceta Bank, a historical groundfishing location and submarine plateau off Oregon's coast. Scientists mapped, explored, and documented the physical, chemical, and biological systems of the Canyon.

Center scientists continued research designed to estimate the relative reproductive success of naturally spawning hatchery salmon.

Center scientists developed a method to differentiate strains of *Vibrio vulnificus* with high potential to cause infection in humans from those that are less virulent.

Center scientists continued to work on combining biological and economic data in assessing the cost-effectiveness of screening irrigation diversions in the Salmon River basin.

The NWFSC developed a framework for analyzing the economic impacts of critical habitat designation for salmon and steelhead under the ESA, and contracted with an outside party to conduct a prospective study of these impacts. Work was also done on identifying potential economic benefits of the critical habitat designations.

Center scientists initiated a study of conservation banking, a means of reducing the costs of mitigation when economic development adversely affects the habitat of an endangered species.

The NWFSC created a stronger link for cooperative research through a Memorandum of Understanding with Washington State University to advance salmon recovery efforts in the interior Columbia.

Research Priorities, FY2004-2009

I.A. Biological Research concerning the abundance and life history of fish stocks

- Conduct baseline assessments for managed groundfish species.
- Improve the level of certainty and confidence in assessments, particularly for stocks in rebuilding plans and intensively fished and managed species.
- Increase groundfish surveys in untrawlable and nearshore habitats using ROV, submersible, fixed gear and acoustic surveys.
- Expand the geographic and seasonal extent of existing pre-recruit surveys to provide more precise information on more species.
- Continue the biennial sampling regime for Pacific whiting. Regular assessments are key for estimating stock size and act as the foundation for advising international harvest levels.
- Participate in the California Current ocean observing program through the Alliance for California Current Ecosystem Observations.

- Develop biologically-based delisting goals for listed salmon and steelhead. This work will be carried out by the Puget Sound, Willamette/Lower Columbia River, and Columbia River Basin Technical Recovery Teams.
- Evaluate the direct and indirect effects of nutrients derived from salmon carcasses on salmon populations.
- Apply extinction risk estimates to salmonid populations to establish rationally-based priorities for recovery goals.
- Continue to conduct west coast groundfish resource surveys from the U.S.-Canada to U.S. Mexican border to improve stock assessments.
- Deploy observers in the groundfish trawl fishery to improve information on total catch for management decisions. Expand observer coverage in other groundfish fisheries. Observers are providing critical new information on bycatch and non-target and protected species for management of the 82 species under the west coast groundfish Fishery Management Plan.
- Conduct studies on the winter distribution, habitat, and prey of Southern resident and transient killer whales. Conduct research on prey resources and contaminants in killer whale prey.
- Conduct Genetic Stock Identification studies to help determine stock allocation under the Pacific Salmon Treaty, help elucidate the ocean migration patterns of listed salmon stocks, and compare different methods of stock identification.

I.B Social and economic factors affecting abundance levels

- Expand sociological and economic research and incorporate results into the fishery management process.
- Develop methods and collect data to facilitate the integration of social science into recovery planning for endangered species.
- Investigate the value of incorporating local knowledge into the design and management of marine protected areas.

I.C. Interdependence of fisheries or stocks of fish

- Explore and quantify the ecological linkages of salmon distribution and survival in estuarine and near shore environments

- Assess both the positive and negative effects of hatcheries on wild salmon populations by measuring the relative fitness of hatchery fish and their descendants when they spawn in the wild and by developing and applying methods for addressing the ecological risks associated with hatcheries.
- Develop and apply population viability models that take into account the genetic and ecological effects of hatchery production.
- Conduct research to better understand and quantify the importance of genetic diversity within and among fish populations.
- Develop and apply molecular genetic tools to identify species, stocks, and individuals.
- Use molecular tools to study the predator/prey interactions between marine mammals and fish populations.
- Use bioenergetic models to provide information on how rockfish growth and consumption are related to climate variability and how changes in mortality propagate through rockfish to their major prey species.
- Characterize and quantify ecosystem services associated with salmon and steelhead populations and their habitats.
- Develop, with partner institutions, a Pacific Coast Observation System.
- Improve understanding of the effects of decadal-scale ocean climate fluctuations on fish productivity to improve forecasts of available yield, improve forecasts of the time needed to rebuild overfished stocks, and improve our ability to understand past trends.
- Developing better indices of ocean conditions to evaluate salmon survival in marine environments.

I.D. Identifying, restoring, and mapping of essential fish habitat (EFH)

- Evaluate the effectiveness of habitat restoration efforts in Washington and Oregon, including evaluating the extent to which placement of structural elements in streams improves habitat quality and increases salmon abundance.
- Develop statistical tools for recovery planning that meld economic costs with biological benefits to ensure that conservation planning is responsive to both economic considerations and biological needs.
- Assess the economic cost and other social impacts of habitat restoration and protection as a strategy for recovering endangered species.

- Develop monitoring and evaluation strategies to help determine the rate and success of salmon recovery.
- Determine what aspects of estuarine conditions are critical to salmon survival.
- Define essential fish habitat and assess the impact of fishing gear on stocks.
- Conduct hydroacoustic surveys to study the distribution and abundance of groundfish species.
- Map and verify essential fish habitat for west coast groundfish.
- Expand surveys to determine how natural fluctuations in the marine ecosystem affect fishery productivity, how human-caused stress affects the ecosystem and fishery, and the complex interactions between fish and their habitats.

I.E. Impact of anthropogenic factors and environmental changes on fish populations

- Develop a bio-physical model that will enable forecasting of HAB events on the U.S. west coast.
- Continue studies to improve our understanding of the fitness of hatchery fish.
- Investigate the links between industrial waste, mining activity, pesticide use, and other physical and chemical alterations of coastal and urban habitats on decreased fisheries productivity. Investigate the effects of chemical contaminants on the growth, development, reproduction, and survival of marine fish and mammals. Establish threshold values for contaminant effects so biological effects on species can be predicted.
- Investigate the impact of ocean variations on salmon by studying salmon distribution, abundance, food habitats, and predator-prey relationships.
- Determine the impacts of non-indigenous species on salmon by developing new statistical techniques, implementing food web modeling and conducting field studies and experiments.
- Determine both the direct and indirect effects of hydropower operations on salmon populations.
- Investigate how natural environmental variations and exposure to contaminants affect juvenile salmon during their passage through estuaries in Washington and Oregon, focusing on how natural and human induced stresses alter growth, neurological function and behavior, and induce disease-related mortality.

- Quantify how salmon use stream and river habitats by collecting descriptive information as well as assessing population responses to different watershed conditions.
- Explore how land use practices such as logging, farming, urban development, and other human activities impact the recovery of threatened and endangered Pacific salmon.
- Improve understanding of the ecological effects of fishing, including which habitats and populations are most susceptible to such impacts, and ways to reduce adverse impacts.
- Provide technical guidance to Technical Recovery Teams on the effect of 12 known classes of toxic contaminants to salmon recovery.
- Conduct studies on the effects of vessel interactions on Southern Resident killer whales and on the effects of climate change on prey of these whales.
- Conduct research on fish prey resources and contaminants in the prey of killer whales.
- As the lead contaminant analysis entity, continue to analyze samples for contaminants under the Marine Mammal Health and Stranding Network.
- Investigate the role of pathogens and parasites in vitality of fish and shellfish populations and as bio-markers of anthropogenic and environmental change on stock health.
- Investigate the response of fish populations to changes in climate and ecosystems.

II. Conservation Engineering Research

Recent Accomplishments:

Since 2001, the Center has developed, implemented and refined a model for projecting bycatch of west coast groundfish species that have been declared overfished. The model produces total bycatch tonnage estimates that are crucial for evaluating whether proposed management of target species is consistent with efforts to rebuild overfished stocks. Beginning in 2003, bycatch and discard rates used in the model were derived from data gathered by the NWFSC's West Coast Observer Program.

Using Center-developed captive broodstock technology, the NWFSC continued cooperative activities to spawn sockeye salmon captive broodstock for use in stock restoration activities. This effort returned more than 300 sea run adults to the Stanley Basin Lakes over the last four years (1999-2002). This is a 19-fold increase over the number of fish returning to the Lakes during the prior eight years (1991-1998).

The Center is providing critical information regarding salmon migration behavior, passage, and survival, using PIT-tag technology. The PIT-tag is a small device, about the size of a grain of rice, with a computer-chip that has been used for many years to detect juvenile salmon as they

move downstream. Prototype systems to detect adults returning to spawn have now been installed and evaluated at several Columbia River dams.

Center scientists continued to develop and use acoustic (sonar-based) technologies that use high-frequency sound pulses to measure groundfish abundance and map their distribution. These technologies are enabling scientists to study groundfish in many more areas of the ocean.

Center scientists began testing, at production scale, in cooperation with the Washington Department of Fish and Wildlife, natural rearing enhancement raceways (NATURES)—hatchery raceways enriched with cover, structure, and substrate to provide salmon with a more “wild-like” environment. These tests will help determine NATURE’s effects on salmon survival once the salmon are released from hatcheries.

NWFSC scientists began research on early life history of west coast groundfish species.

The Center is developed breeding and rearing technologies for several key groundfish species. Center scientists developed new culture techniques to successfully rear yelloweye rockfish through its sensitive larval phase. This is the first time that this species has been reared in captivity beyond 30 days. Yelloweye rockfish stocks are severely depleted with rebuilding plans that are estimated to take from 40-170 years using current management approaches. The successful culture of yelloweye rockfish larvae is the first step needed to determine if stock enhancement strategies can assist in the rebuilding process.

Center scientists worked with partners to develop a new trawl design that is more effective at catching flatfish.

Research Priorities, FY 2004-2009:

- Conduct fishing gear performance and fish behavioral studies to reduce bycatch and bycatch mortality of prohibited, undersized, or unmarketable species, and to understand performance of survey gear.
- Develop conservation hatchery technology to aid recovery of ESA-listed stocks of Pacific salmon. Further develop the Natural Rearing Enhancement System (NATURES), a system for culture of Pacific salmon in raceways that simulate natural environments to develop salmon with characteristics and behavior more like their wild counterparts.
- Develop and improve broodstock technology to restore depleted Pacific salmon stocks.
- Develop methods to identify and control pathogenic microorganisms, including bacterial kidney disease, that threaten fishery resources, by conducting genetic studies of the pathogens, characterizing host-pathogen interactions, and developing highly sensitive molecular techniques.
- Continue advancing PIT-tag technology to promote safe and efficient fish passage through hydropower systems, and other unnatural barriers, and to gain understanding of migration patterns upstream and downstream.

- Develop new technology to study prey resources and distribution of killer whales.
- Develop and employ advanced and innovative technologies to monitor and survey fisheries and marine ecosystems.

III. Research on the Fisheries

Recent Accomplishments:

Center and University of Washington scientists provided evidence showing that an important source of Pseudo-nitzschia, the algae that produce the neurotoxin domoic acid, may be located off of Cape Flattery in the Juan de Fuca eddy.

Initiated a program to collect West Coast recreational fishing data with an emphasis on participation in the recreational groundfish fishery.

Conducted a comprehensive review of existing West Coast groundfish trawl cost-earnings data.

Developed objectives and methodology for cost-earnings data collection program covering West Coast groundfish fisheries.

Conducted a pilot research project on methods for enumerating and profiling Washington Coast groundfish communities.

Initiated community profile database research for West Coast fishing communities.

Hired an economist and anthropologist to develop models and collect data on recreational fisheries and improve critical socioeconomic studies.

Successfully captured, spawned, and reared, for the first time, Puget Sound Pacific cod larvae, which will help determine if the stocks that traditionally spawned in Puget Sound differ genetically from the larger Pacific cod stocks and if cultured juveniles can be used to rebuild Pacific cod in Puget sound.

Increased communication between resource managers and research scientists to create an effective HAB monitoring program, which includes early warning of shellfish toxification events. This approach has led to a greater number of beach openings for razor clam harvest and legislators in Washington recently permitted an increase in razor clam digging license fees to enable the program to continue under state support.

Research Priorities, FY 2004-2009:

III.A. Social and economic research

- Analyze current and historical operating costs and activity patterns in the fishing industry and indicate how each group would be economically impacted by changes in fishing gear use and area restrictions, limits on individual catch, and/or direct allocation between user groups.
- Develop economic data collection program and models of economic performance for West Coast groundfish fisheries
- Collect and analyze stated preference and expenditure data for West Coast recreational fisheries
- Develop economic models of bycatch for West Coast groundfish fisheries
- Investigate the interdependence of West Coast fishing communities on one another and their social and economic dependence on North Pacific and other non-West Coast fisheries
- Describe and enumerate West Coast environmental justice fishing communities
- Characterize and quantify non-consumptive economic and social values associated with Northwest marine mammal populations
- Analyze the economic and social impacts of fishery closures brought on by harmful algal blooms and other marine biotoxins
- Conduct research and data collection to prepare the economic status of west coast groundfish fisheries as part of the annual Groundfish SAFE reports.

III. B. Seafood safety research

- Explore more complete utilization of marine resources by developing methods to recover more flesh from targeted fish species and to identify and control naturally occurring microbial pathogens that limit shellfish harvests.
- Develop methods to identify and analyze marine toxins and the algae that produce them. Ascertain how these toxins are transmitted and their effect on target organisms. Determine the health risks that biotoxins pose for fish and shellfish.



NMFS scientist stands near incubation unit for culturing phytoplankton for marine biotoxin studies, Phytoplankton Culturing Laboratory, NWFSC.

- Identify and characterize key virulence determinants that enable *V. vulnificus* to cause human infections, using comparative genomics and other molecular genetic means. This information will be used to develop methods to treat the disease caused by this pathogen.
- Develop rapid methods to identify and characterize pathogenic bacteria in seafood-related products. These include rapid and easily-used “kit” methods to detect pathogenic strains of *V. vulnificus* from non-pathogenic ones.
- Expand identification of parasitic infections in commercially important marine fish, both geographically and in the number of different marine fish species examined, to better determine environmental variables that alter infection.

III.C. Marine aquaculture

- Develop laboratory aquaculture techniques for targeted marine species, by studying aquaculture engineering, fish physiology, nutrition, pathology, and developmental biology to relieve pressure on severely depressed wild marine stocks.

IV. Information Management Research

Recent Accomplishments:

Developed a web-based salmon database that is currently available online. This database consolidates existing data from hundreds of sources into a consistent database that is geospatially linked.

Developed, with the Office of Marine and Aviation Operations, a portable version of the Fisheries Scientific Computer System (FSCS) for use on charter vessels used for west coast surveys. The FSCS is a data acquisition system designed specifically to digitally collect all critical fishery-independent data aboard fisheries research vessels.

Developed a prototype of the Electronic Fish Catch Logbook—a system for collecting and integrating fishery-dependent data from fishers, processors, observers and biologists using electronic means.

Launched the Center’s new website, which provides critical information to the public on the Center’s activities, as well as a new cooperative research website, in partnership with the Pacific States Marine Fisheries Commission, to serve as a west coast-wide clearing house for information on cooperative fisheries research.

The Center expanded its participation in a collaborative partnership that is being led by Oregon Sea Grant to create a website that strengthens the connection of fishermen, fishing families, industry, communities, agencies, and other groups. The website posts current information on industry, safety, family, and seafood issues.

Center scientists partnered with the Pacific States Marine Fisheries Commission, Pacific Fishery Management Council, and the Pacific Marine Conservation Council to create a new cooperative research website. This website will serve as a west coast-wide clearing house for information on cooperative fisheries research and is intended to match parties with interests in collaborative research and identify a broad range of funding sources.

Research Priorities, FY 2004-2009:

- Develop statistical approaches to improve monitoring and evaluation of threatened and endangered species.
- Improve Cumulative Risk Initiative web-based reporting system outputs by strengthening links to raw data and other information sources.
- Continue expanding capabilities and consolidating existing data from hundreds of sources into a consistent database that is geospatially linked to support salmon and groundfish analyses.
- Continue to provide information products based on experts and technical data that support NMFS, the regional office, the Councils, international scientific commissions, and the overall research and management community.

SOUTHWEST FISHERIES SCIENCE CENTER (SWFSC)

The Southwest Fisheries Science Center (SWFSC) headquarters is located in La Jolla, CA, and research is conducted at laboratories in La Jolla, Santa Cruz, and Pacific Grove, CA. The current staffing level involved in MSFCMA-related activities is at about 95 full-time equivalents (FTEs). An estimated 55% of total SWFSC resources are assigned to MSFCMA activities. NOAA research vessels assigned to fisheries research in the SWFSC are the NOAA R/V *David Starr Jordan*, which has San Diego, CA, as its homeport, and about two-thirds of the NOAA vessel *McArthur II*'s time. The Center also charts in excess of 100 sea days annually aboard both fishing and research vessels.



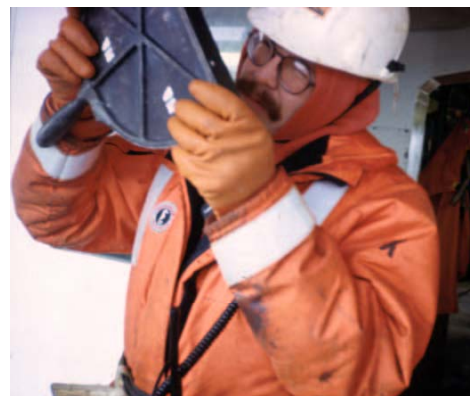
Southwest Fisheries Science Center, La Jolla
Laboratory and Headquarters, La Jolla, CA.

The SWFSC is a world-class research organization which conducts integrated, multi-disciplinary research programs in biology, mathematics, oceanography, and economics for the purpose of developing scientific technology and information to support the management and allocation of Pacific coastal and high-seas fishery resources. These activities support the scientific, statistical, and economic needs of the Pacific Fishery Management Council and international commissions for large pelagic fishes and Antarctic resources. Center programs also support efforts directed toward the reduction of protected species interactions, fishery-related

porpoise mortality, and a better understanding of the biological and environmental factors affecting the marine resources exploited by U.S. commercial and recreational fisheries. The Center provides the scientific information necessary to conserve and manage the following important fisheries in the Pacific and Antarctic regions:

- Large pelagic fishes of the Pacific Ocean (tuna, billfish, shark, and swordfish).
- Groundfishes of the west coast (Pacific hake, rockfishes, lingcod, cowcod).
- Small coastal pelagic species of the west coast (northern anchovy, sardine, mackerel, squid).
- Salmon of the west coast.
- Antarctic krill, crabs, finfish (including Patagonian toothfish).

The Southwest Fisheries Science Center specializes in fisheries of the California Current, Pacific Oceanic, and Antarctic regions. Research is carried out on the ecology, population dynamics, fisheries, and stock assessment of small coastal pelagic species, west coast groundfishes, Pacific billfish, tunas and sharks, and California salmon. The Center maintains and utilizes the largest database on tuna and tuna-related fisheries in the world. The Center makes extensive use of biological and fisheries data, which are collected by observers placed on fishing vessels by the Southwest Region, to monitor interactions with protected resources to achieve goals related to the MSFCMA. It is also considered a leader in fish survey design, conducting surveys to monitor early recruitment success of economically important fish stocks along the U.S. west coast. It is a co-founder and co-participant in the Pacific Coastal Observing System (PaCOS) an extension of the now famous State-Federal California Cooperative Fisheries Investigations (CalCOFI), a comprehensive long-term study of the biology and oceanography of the California Current. In the Pacific, the Center is the leading source of stock assessment expertise on tunas, sharks, and billfishes for international commissions and for the Pacific Fishery Management Council. In the Antarctic, the SWFSC leads U.S. research directed at gathering ecological information to prevent overexploitation of fish and krill and to protect Antarctic living marine resources. The SWFSC provides oceanic environmental data and indices to the rest of NMFS as well as to other Federal, state, academic, and foreign fisheries scientists. Center scientists are leaders in the research and



NMFS scientist measures wire angle to deploy CTD array.



CTD array is deployed off NOAA R/V Miller Freeman to take conductivity, temperature, and depth measurements.

development of fisheries-relevant environmental data products. The SWFSC is home to a NOAA CoastWatch node at its Pacific Fisheries Environmental Laboratory.

SWFSC scientists have taken the lead in characterization of large- and small-scale habitats that support white abalone, groundfish and bottomfish populations in deep water off California. This work requires an interdisciplinary approach from fishery biologists, geologists, and ecologists and couples the use of GIS with remote-sensing visual and acoustic tools, *in situ* survey techniques using remote operated vehicles, submersibles, and spatial analyses. This approach is being applied to the identification of EFH for various species, the improvement of stock assessment surveys, development of endangered species recovery plans and the evaluation of MPAs as an effective supplement to traditional fishery management. The National Ocean Service's MPA Center is cooperatively co-located with the SWFSC's Santa Cruz Laboratory.

The SWFSC maintains an active communications network with constituents, colleagues in the scientific professions, and the public to receive input for research planning, execution, and results. The network includes frequent dialogue with commercial and recreational fishers, leaders of environmental groups, participants of fishery management councils, state and Federal research agency staff, and outside scientists in the United States and foreign countries. Supporting this network is an infrastructure that includes cooperative agreements to support collaborative work with researchers in state agencies, universities, and foreign governmental agencies for collecting logbook and other types of fisheries data and for shared research projects; arrangements for data exchange; and contracts for charters of research vessels and specialty expertise. The SWFSC and its laboratories maintain up-to-date Internet sites that provide a range of information, including scientific reports and summary data bases available to other researchers as well as the general public.

The SWFSC provides scientific and research support for U.S. commitments resulting from the following international arrangements and agreements in the Pacific region: (1) Convention for the Conservation of Antarctic Marine Living Resource (CCAMLR), which manages the marine living resources of the Antarctic; (2) Inter-American Tropical Tuna Commission (IATTC), which deals with tuna and tuna-like fishes, and the tuna-dolphin issue of the eastern Pacific Ocean; (3) South Pacific Tuna Treaty (SPTT), which provides tuna fishing access to the western Pacific Ocean; (4) North Pacific Interim Scientific Committee for Tuna and Tuna-like Species (ISC), which promotes research on tuna and tuna-like species of the North Pacific Ocean; (5) Standing Committee on Tuna and Billfish of the Secretariat of the Pacific Community (SCTB), which facilitates collaborative research on tuna and billfish of the western Pacific Ocean; (6) MEXUS Pacifico, which promotes joint U.S.-Mexico research projects of mutual interest; (7) North Pacific Albacore Workshop (NPALB), which promotes stock assessment research for north Pacific albacore; (8) Commission on the Conservation of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean (MHLF), which will manage the highly migratory fish resources of the western and central Pacific Ocean; and (9) International Whaling Commission (IWC), which promotes conservation of whale stocks. In addition, SWFSC scientists periodically work jointly with other scientists on projects sponsored by international organizations such as the UN Food and Agriculture Organization (FAO), Global Ecosystem Dynamics (GLOBEC), and the North Pacific Marine Science Organization (PICES).

The Southwest Fisheries Science Center maintains an exceptional and growing fisheries economic research capability. Special studies are undertaken to help explain and evaluate the potential impacts of various management options on components of the fishery or the public. In addition, economic data collection and analyses are carried out to evaluate the economic health of fisheries or components of the fisheries.

Recent Accomplishments and Research Priorities for FY 2004-2009

I. Research to Support Fishery Conservation and Management

Recent Accomplishments:

Studies on the basic biology, movement, and population status of North Pacific Highly Migratory Species and sharks (HMS) were completed and incorporated into the PFMC HMS Fishery Management Plan, the most recent FMP for the management of HMS resources in the North Pacific. This work has involved collaboration with fisheries scientists from around the Pacific, including scientists from state, university, and resource user groups.

A multi-national synoptic survey of krill biomass of Antarctic Statistical Subarea 48 (Peninsula, S. Orkney, S. Georgia, and S. Sandwich) was completed. As a result of a five-year planning effort, one ship from the U.S., United Kingdom, Japan, and Russia each conducted a one-month acoustic/oceanographic survey of the above areas and the open-ocean areas between each island group. This was a CCAMLR-sponsored survey with the participation of scientists from the International Whaling Commission. The U.S. convened a CCAMLR workshop to complete analyses of survey data.



Trawl-caught California market squid

The Groundfish Program provided PFMC with stock assessments for bocaccio rockfish, cowcod rockfish, widow rockfish, canary rockfish (south), and lingcod (south), as well as rebuilding analyses for bocaccio and cowcod rockfish and Pacific ocean perch. SWFSC staff initiated and convened a review of harvest rates for west coast groundfish, resulting in significant revision of PFMC management policy. Midwater trawl surveys provided annual indexes of rockfish recruitment strength for use in stock assessments and analyses of environmental influences.

A recent analysis of atmospheric observations in the North Pacific revealed extensive decadal-scale variations in the mid-latitude winter surface wind stress. In the decade after the winter of 1976, eastward wind stress doubled over a broad area in the central North Pacific and the core of the North Pacific Current was displaced about 360 nautical miles southward. The result was that surface water entering the California Current was of more subtropical origin in the post-1976 decade. All factors considered contributed to a multi-decadal temperature pattern of warm, nutrient-poor surface waters in the California and Alaska current regions. In association with the 1976 climatic shift, marine fishery production in the Oyashio, California, and Alaska currents

altered dramatically, suggesting that natural environmental variation significantly alters the long-term yields from many North Pacific fisheries.

Research Priorities, FY 2004-2009:

I.A. Biological research concerning the abundance and life history parameters of fish stocks

- Conduct biological research by the U.S. Antarctic Marine Living Resource Program concerning abundance and life history parameters of fish stocks.
- Plan, conduct, and present results of annual predator/prey interaction studies in waters around South Shetland Islands, Antarctica.
- Develop a new Bayesian method of stock assessment for application to data-poor groundfish species.
- Develop an advanced technology-based groundfish survey using optical and sonar for the Southern California Bight.
- Develop a population genetics database of all anadromous California salmonid stocks for determination of stock structure and as a baseline for future monitoring efforts.
- Provide quantitative estimates of the take of listed salmon in the California salmon harvest and evaluate proposals to minimize listed species take.
- Expand the archival tagging program for North Pacific albacore in cooperation with the albacore fishing industry, Japanese fishery agencies, and other groups to trace their movements between fisheries and countries.
- Define unit stocks using genetics and otolith chemistry in highly migratory species (albacore, thresher shark, and striped marlin), in coastal pelagic species (sardine), and in groundfishes.
- Conduct peer-reviewed assessments and statistical analyses on stocks of groundfish, coastal pelagics, tunas, sharks, swordfish, salmon, and other species.
- Develop a new generation of stock assessment models for highly migratory species and coastal pelagic species stocks of the Pacific and the state-of-the-art software to support them, using modern statistical optimization techniques, Bayesian methods, and object-oriented programming languages.
- Use pop-up satellite tags to identify forage and migration habitats of exploited shark species in the California Current.

I.B. Social and economic factors affecting abundance levels

- Expand economic research and incorporate results into the fishery management process.
- Develop behavioral models of economic incentives affecting the level and allocation of fishing effort in FMP fisheries.
- Initiate an economic survey of the Southern California HMS recreational fishery.
- Enhance existing salmon harvest models to better predict fishing effort response to changes in sport and commercial fishery regulations.
- Conduct Regulatory Impact Reviews and Regulatory Flexibility Analyses for management actions being considered for all FMP fisheries.
- Evaluate growth in productivity for purse seine vessels harvesting tuna in the western and central Pacific, paying special attention to the effects of fish aggregating devices (FADs).

I.C. Interdependence of fisheries or stocks of fish

- Continue research program under the International Dolphin Conservation Protection Act to determine whether the chase and encirclement by the fishery is having a significant adverse impact on depleted dolphin populations in the eastern tropical Pacific.
- Design sampling surveys to analyze the impact of marine mammals on listed salmon.
- Develop integrative oceanic environmental indices to improve understanding of how environmental variability affects fish stocks.

I.D. Identifying, restoring, and mapping of essential fish habitat (EFH)

- Participate in salmon EFH identification and protection.
- Develop and produce digital mosaics of seafloor habitats from electro-optic images into a format compatible with other geo-referenced data sets used in GIS.
- Develop approaches to evaluate essential habitat of pelagic fishes based on satellite remote sensing and applications of archival and pop-up satellite tags.
- Evaluate EFH and monitor marine resources in newly created "no-take" marine reserves planned for the Channel Islands National Marine Sanctuary.
- Define essential spawning habitat of market squid and the effects of fishing gear on that habitat and the survivorship of demersal egg capsules.

I.E. Impact of anthropogenic factors and environmental changes on fish populations

- Investigate relationship of juvenile salmon abundance and physiological status with respect to oceanographic features (e.g., estuary plumes, upwelling centers, coastal jets, eddies, and fronts).
- Determine the effects of hatchery and aquaculture operations on indigenous salmon and steelhead stocks in California by molecular genetic analysis of museum specimens and previously collected scale samples.
- Evaluate the effects of climate change of interannual, decadal, and centennial scales on fisheries and fish habitat.
- Develop models of the impacts on salmon populations of natural disturbances due to climatologies.
- Improve methods to identify pathways in estuarine ecosystems for the bio-accumulation of contaminants in salmon.
- Examine the association of recruitment of young rockfishes and climatic and oceanographic variables off central California.
- Investigate use of small estuaries on central California coast by juvenile salmonids. Assess the effects of environmental variability, particularly sandbar dynamics and water quality, on growth, development, and survival.
- Investigate the linkage between the dynamics of oceanic features, including eddies, fronts, and boundary currents, and the dynamics of highly migratory fishes (tunas and billfishes) in the central and western Pacific.

II. Conservation engineering research

Recent Accomplishments:

An analysis of acoustic backscatter from an acoustic Doppler current profiler (ADCP) and surface temperature and salinity continuously sampled in relation to the continuous underway fish egg sampler provided a description of the sardine spawning habitat. This detailed observational analysis shows, on a survey-by-survey basis, that eggs and larvae are found in waters that are transitional between those that are freshly upwelled and those of the California Current proper.

The SWFSC completed research to improve our understanding of fisheries impacts on marine ecosystems. The study pioneered the use of the combination of acoustic techniques, fishing information, and direct submersible research to directly evaluate deepwater fisheries habitat. Research published considered the potential of side-scan sonar to enumerate the frequency of trawl tracks on soft bottom environments, suggesting that acoustic remote sensing is a promising

independent approach to evaluate fishing effort on a scale consistent with commercial fishing activities.

Research Priorities, FY 2004-2009:

- Undertake studies to determine the most effective methods to increase survival of sea turtles on nesting beaches in the eastern and western Pacific.
- Determine how to increase survival in the economic/regulatory discards of undersized tunas, sharks, and other fishes.
- Create and test new trap designs for juvenile out-migrant salmon that will minimize predation on juveniles from larger salmonids (in cooperation with Humboldt State University).
- Develop advanced survey technology for monitoring abundance of fishes including: (1) use of LIDAR for monitoring the abundance of CPS species; (2) remote monitoring of FAD fish aggregations; and (3) species identification algorithms for acoustic surveys.
- Develop advanced technology for automatic shipboard data logging of bio- acoustic and environmental data from standard equipment on commercial fishing vessels and logging of catch. Develop algorithms for processing and analysis of these data.

III. Research on the Fisheries

Recent Accomplishments:

The SWFSC initiated and led the efforts to evaluate MPAs as a supplemental tool for groundfish management on the west coast. The Center organized and convened the first workshop on marine harvest refugia to conserve and manage rockfish and continued these discussions in a special symposium on marine protected areas for California. The published proceedings and reports are also being used by west coast states in evaluating marine reserves as a strategy to conserve and manage nearshore marine resources.

Coho salmon production in the Pacific Northwest reached historically low levels in the 1990s, which stimulated research examining whether changes in ocean conditions were responsible for inter-annual variability in the ocean survival of coho. Recent investigations focused on improving the measures of ocean conditions using remotely sensed sea surface temperature (SST) data and by weighting upwelling indices with sea surface temperatures. The models generated from the analyses may have the potential to be used for coho survival forecasting. Related research evaluated how spatial patterns of environmental variability may differentially affect parts of the coho populations.

The SWFSC completed an analysis of harvesting capacity in the Pacific coast CPS limited entry finfish fishery. The Center also collaborated on an analysis of harvesting capacity in the Pacific coast market squid fishery. The Center completed cost-earnings surveys on drift gillnet and

albacore troll fisheries as a part of the new HMS FMP. Multifan CL was applied to develop stock assessments for highly migratory species.

Research Priorities, FY 2004-2009:

III.A. Economic research

- Initiate economic evaluation of salmon hatchery reform actions.
- Develop automated analytical templates integrated with current fishery performance, cost, and price information for completing RFAs in an efficient and timely basis. Augment these templates to include the basic demographic information required to initiate preliminary SIAs.
- Conduct research to support the United Nations Implementing Agreement (or Provision of the United Nations Convention on the Law of the Sea (UNCLOS) Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks).
- Research intra-industry linkages and develop input-output relationships to describe and model the employment, income, and economic activity impacts of management actions being considered for each of the FMP fisheries and fishing communities.
- Evaluate and describe economics associated with sea turtle conservation and develop models for increasing national benefits.

III.C. Marine aquaculture

- Develop techniques for culture of white abalone and other abalone species for recovery of endangered stocks, stock enhancement, and commercial production.

IV. Information Management Research

Recent Accomplishments:

The SWFSC's Pacific Fisheries Environmental Laboratory (PFEL) provides environmental data for fisheries research and management. Environmental variability has been identified as a key feature in fish and marine mammal population dynamics. PFEL's data holdings and related data products provide fisheries relevant data that cover the entire spectrum of the ocean environment—from surface or near-surface wind and pressure data that can affect the ocean, to surface and subsurface measurements of important oceanographic parameters. Over the last year, PFEL has developed a system to make this information readily accessible to fisheries scientists. Scientists can now obtain over the Internet most of the PFEL's data holdings, for any location in the world. The data can be sorted in both space and time, visualized on-line, and downloaded in a variety of formats. Data and expertise were provided to researchers working on salmon survivorship, hake

catches and negotiations with Canada, harmful algal blooms, rebuilding overfished fish stocks, benthic fauna patterns in sanctuary areas, and marine mammal population dynamics.

Data collected and processed from U.S. purse seiners fishing in the central-western Pacific were computerized, edited, and submitted to the Forum Fisheries Agency (Treaty Manager) as required under the SPTT. This information was reported at the Annual Treaty meeting of the Forum Fisheries Agency in Nuie and also presented at the meeting of the Standing Committee of Tunas and Billfish in New Caledonia for use in stock assessments of central-western Pacific skipjack, yellowfin, and bigeye tuna stocks.

The SWFSC fielded three observers aboard U.S. troll vessels to collect length measurements of albacore and bycatch estimates to verify and supplement data taken by port samples and in logbook records. The data were computerized and presented to the North Pacific Albacore Workshop in Taiwan and used to assess the status of Pacific albacore stocks. These data were also analyzed and distributed to U.S. albacore fishers.

The SWFSC organized an initiated an ongoing HMS data organization and data sharing committee to address data compatibility, reporting and availability for data holdings of the Pacific Islands and Southwest Regions and the Pacific Islands and Southwest Science Centers.

Research Priorities, FY 2004-2009:

- Automate quarterly and annual compilation of fisheries statistics and annual reports on FMP fisheries.
- Develop and maintain web-based coastal salmon abundance database.
- Advance approaches of data fusion to combine fisheries data and assessment model outputs with environmental data from ship, satellite, and physical models.
- Coordinate HMS data organization and data sharing between the Pacific Islands and Southwest Regions and the Pacific Islands and Southwest Science Centers.

SOUTHEAST FISHERIES SCIENCE CENTER (SEFSC)

The Southeast Fisheries Science Center (SEFSC) with headquarters in Miami, Florida, implements and manages a multi-disciplinary science and research program that provides technical information for conserving and maintaining the sustainability and health of living marine resources and their environments. SEFSC is responsible for the eight southeastern states, Puerto Rico, and the U.S. Virgin Islands, and research is conducted at laboratories located in Miami, FL; Panama City, FL; Beaufort, NC (a joint NOS-NMFS facility); Galveston, TX with a lab facility in Lafayette, LA; and Pascagoula, MS, with a field station at the Stennis Space Center. There are also numerous field offices providing additional information for research along the coast of the southeastern United States. SEFSC has two fishery research vessels

berthed at Pascagoula, Mississippi: the NOAA vessels *Oregon II* and *Gordon Gunter*, as well as numerous smaller research craft located at individual laboratories. In general, SEFSC develops the scientific information required for: (1) fishery resource conservation, (2) fishery development and utilization, (3) habitat conservation, and (4) the protection of marine mammals and endangered species. Impact analyses and environmental assessments for fishery management plans and international negotiations are also prepared, and research is pursued to address specific needs in population dynamics, fishery biology, fishery economics, engineering and gear development, and protected species biology. SEFSC's current staffing level is 272 FTEs, with all positions involved in MSFCMA-related activities. Approximately 80% of all SEFSC resources are devoted to MSFCMA activities.



Southeast Fisheries Science Center Miami
Laboratory and Headquarters, Miami, FL.

Each SEFSC laboratory is responsible for conducting research in specific subject areas and also tend to have specific geographic focuses, however, there is extensive cooperative research between SEFSC laboratories. Research activities conducted by the various laboratories are as follows:

Beaufort Laboratory:

Conducts research on biology and fishery for reef fish, including headboat landings, fishing effort, age and growth, reproduction, and assessment of abundance, to support the management of territorial sea, EEZ, and highly migratory resources. Conducts research on processes affecting the distribution, abundance, and use of natural and restored habitats by fishery organisms, and develops techniques and methodologies to evaluate natural and anthropogenic impacts on fishery organisms and their habitat. The program also supports conservation and recovery efforts through evaluations of marine protected areas and also provides scientific recommendations to Fishery Management Councils. Carries out NMFS' mandates for the recovery and conservation of protected species under the MMPA, the ESA, and related legislation.

Miami Laboratory:

Performs stock assessments for species such as snapper-grouper, mackerels, highly migratory species (e.g., sharks, swordfish, tunas, and billfish). Scientists also collect and analyze: 1) catch and effort data and 2) scientific information under the Fishery Observer Program for addressing issues such as bycatch of protected species, the assessment of bycatch mitigation techniques and discard mortality of targeted species; supports cooperative research science projects with constituents, states and local governments; conducts economics and social science research to evaluate the socioeconomic impacts of existing and proposed fishery management actions.

Implements research to support the conservation and recovery of depleted, threatened, and endangered species of marine mammals and sea turtles by: conducting species-population assessment surveys; research on stock structure including genetics, radio tagging, photographic identification, and morphological studies; assessing strandings and unusual stranding events.

Performs research on: “no-take” marine reserves as a fishery management tool to support sustainable fisheries and protect marine biodiversity; ecosystem structure and function; coral reefs, essential fish habitat; habitat restoration; the effectiveness of artificial reefs; and fishing gear effects on populations and habitat; biological research to support stock assessments; fishery-independent assessments; early-life history and early-life ecology of southeastern species.

Conducts research to ensure that coastal ecosystems are improved and are not harmed by the Comprehensive Everglades Restoration Project, which will modify freshwater inflow to estuaries and near shore areas in southern Florida.

Panama City Laboratory:

Conducts research in fishery biology, life history, recruitment dynamics, ecology, essential fish habitats, and fisheries for economically important reef fishes, coastal pelagic fishes and sharks; gear selectivity patterns; impacts of fishing gear on bottom habitats; documents the extent and nature of reef habitat and economically important reef fishes within marine reserves; coral reef research; ecosystem studies; monitor certain fisheries for their impacts on whales and sea turtles and stock assessments and population modeling.

Mississippi Laboratories:

Develops fishery-independent estimates of reef fish abundance; conducts annual trawl surveys to monitor the status of fish and invertebrates; assesses the abundance and distribution of coastal sharks; implements endangered species research; conducts visual and acoustic assessment surveys of cetacean stocks; conducts research and development for Turtle Reduction Devices (TEDs) and Bycatch Reduction Devices (BRDs), and longline interactions. Performs environmental remote sensing; and distributes CoastWatch/OceanWatch operational data.

Galveston Laboratory:

Conducts research on: essential fish habitats and the use of landscape techniques to identify Essential Fish Habitat by integrating GIS tools into assessments of habitat value; habitat modifications caused by sea level rise, subsidence, changes in freshwater inflow, coastal eutrophication, and broad scale hypoxia; habitat restoration research; wetland restoration; ecosystem models for estuarine and coral reef systems. Research to determine, monitor, and describe shrimp population characteristics; monitors bycatch on shrimp trawl vessels using fishery observers and turtle and marine mammal interactions during petroleum platform removal operations; conducts captive rearing of loggerhead sea turtles for use in turtle excluder device (TED) certification trials and other fishery-related studies (e.g. turtle responses to the long line fishing gear).

SEFSC provides scientific support for NMFS' fishery management activities for the South Atlantic Fishery Management Council (SAFMC), the Gulf of Mexico Fishery Management Council (GMFMC), and the Caribbean Fishery Management Council (CFMC), that involve 17 fishery management plans covering the following major fisheries: spiny lobster, snapper-grouper, reef fish, red drum, coastal migratory pelagic species, coral, shrimp, stone crab, queen

conch, and golden crab. SEFSC also has significant interactions with the Gulf States Marine Fisheries Commission (GSMFC), which administers the Fisheries Information Network (FIN) statistics effort; and the Atlantic States Marine Fisheries Commission (ASMFC), which administers the ACCSP and exercises fishery management responsibilities through the Atlantic Coastal Fisheries Cooperative Management Act. In addition, SEFSC maintains close ties with state fishery programs and has funded the State/Federal cooperative statistics program since 1983. Researchers at the SEFSC collaborate extensively with other Federal agencies and academia.

Internationally, the SEFSC provides scientific support for U.S. participation in: (1) the International Commission for the Conservation of Atlantic Tunas (ICCAT), which manages Atlantic Ocean-wide fisheries for tunas and billfishes; and (2) the International Oceanographic Commission for the Caribbean (IOCARIBE), which coordinates fishery oceanography studies among the approximately 30 islands and continental countries in the region. SEFSC scientists also work jointly with the government of Mexico on projects of mutual interest in the Gulf of Mexico under the Mexus-Gulf research working group.

Constituents have the opportunity to provide input to SEFSC's research programs through representation on FMCs, participation in Council public hearings, and service on Council advisory committees. Input to the SEFSC research program is also received via the activities of interstate fishery commissions (the Atlantic and Gulf States Marine Fisheries Commissions), joint agency planning groups, and cooperative programs with state fishery agencies (GulfFIN). SEFSC responds to the information needs of fishery management councils and has a formal procedure (Council Operations Plan) for matching its research program to fishery management plan requirements.

SEFSC's high caliber of research is maintained through periodic program reviews by teams that include officials from industry, councils, state agencies, universities, and other constituents. The Center also works diligently to be responsive to the results of program reviews.

Recent Accomplishments and Research Priorities for FY 2004-2009

I. Research to Support Fishery Conservation and Management

Recent Accomplishments:

SEFSC has been instrumental in the development of the improved FMC-led Southeast Data Assessment and Review (SEDAR) process for conducting stock assessments. SEDAR emphasizes constituent/stakeholder participation and an independent scientific review of stock assessments, and benefits greatly from the expertise of existing stock assessment-related committees and panels of Councils and Commissions.

SEFSC has successfully incorporated "risk assessment," "uncertainty," and the new SFA guidelines on "overfished" and "overfished status" into stock assessment methodologies for numerous species in the Gulf of Mexico, Atlantic, and Caribbean.

The development of the red snapper rebuilding plan was based on SEFSC scientific efforts.

The Center is recognized for its expertise in the fields of habitat research and restoration and has successfully developed criteria to define and assess areas of EFH.

SEFSC completed baseline data collection essential for the successful establishment of marine reserves in the Tortugas region for the Florida Keys National Marine Sanctuary and for the Dry Tortugas National Park.

SEFSC has conducted a worldwide review of the nursery value of salt marshes for fishery species in comparison with other estuarine habitat types.

Research Priorities, FY 2004-2009:

I.A. Biological research concerning the abundance and life history of fish stocks

- Understand and model the linkages between habitats, environmental characteristics, and fishery productivity.
- Develop and maintain high quality fishery-dependent and fishery independent long-term data sets for stock assessments. A main component of this effort will be the expanded use of at-sea observers on commercial and recreational fishing vessels to report on catch and bycatch. Emphasis will be on collecting a wide range of information, including biological and environmental data, gear type deployed, and method of deployment.
- Incorporate marine ecosystems data into conceptual models of food webs to link habitat to productivity and increase the Center's ability to survey, inventory, and understand the dynamics of marine systems and their biota.
- Continue to assess and monitor protected finfish species (e.g., goliath grouper and Nassau grouper).
- Conduct research on HMS stocks, particularly in the areas of stock identification, life history, and precautionary approach methodologies.
- Develop basic life history information and conduct assessments on fish stocks in support of management for the Councils (SAFMC, GMFMC, and CFMC) and Commissions (ASMFC, GSMFC).
- Improve the effectiveness of fishery resource management programs by refining the definition of stocks (including the "management unit" within species)



NMFS scientist measures fish, aboard R/V Oregon II.

I.B. Social and economic factors affecting abundance levels

- Expand sociological and economic research and incorporate results into the fishery management process.

I.C. Interdependence of fisheries or stocks of fish

- Increase our understanding of the interactions of protected species (e.g., sea turtles, marine mammals: bottlenose dolphin and large whales) and finfish candidate species (e.g., goliath grouper and Nassau grouper) with ongoing fisheries in the Southeast Region.
- Prevent the extinction and promote the recovery of marine species and at-risk populations through interventions and the continued development of recovery strategies.
- Develop scientific methodology for multi-species or ecosystem approaches towards the management of fishery resources, and where appropriate, transition from single-species approaches.

I.D. Identifying, restoring, and mapping of essential fish habitat (EFH)

- Define and characterize EFH and develop an understanding of natural and anthropogenic threats.
- Develop mapping techniques for more precise positioning of boundaries and for evaluation of fishery values of existing and proposed marine reserves.
- Investigate downstream and coastal impacts of agricultural and urban activities and provide the technical basis for designing and implementing programs for ensuring sustainable coastal communities.
- Gain a better understanding of the structure and function of estuarine, coastal, and marine systems to enhance the conservation and restoration of wetland, benthic, and aquatic areas of EFH.
- Explore innovative techniques to determine the functional value of natural habitats and to evaluate the restoration success relative to the fish community rather than solely to the plant community.
- Develop restoration techniques for EFH including corals, salt marshes, and seagrasses; and determine whether habitats created or restored with such techniques are ecologically functional.
- Integrate EFH research with stock assessments to develop an ecosystem approach for managing fisheries.

I.E. Impact of anthropogenic factors and environmental changes on fish populations

- Continue to engage in joint efforts with state and other Federal agencies to restore the ecological integrity and water quality in regional estuaries upon which fish depend.
- Continue research efforts under the South Florida Restoration Effort, particularly in the areas of modeling fishery dynamics, recovery of protected resources, restoring EFH,
- Determine the impacts of fishing on reef fish population structure, genetic diversity and resilience.
- Derive more accurate assessments of fishing and other anthropogenic impacts on living marine resources by incorporating risk and uncertainty into models used to predict natural living marine resource variations.
- Develop techniques and scientific data necessary to support the effective application of precautionary approaches to fisheries management.
- Continue to evaluate the efficacy of marine reserves, no-take and limited-take zones, and time closures as fishery management tools.

II. Conservation Engineering Research

Recent Accomplishments:

Innovative approaches to BRD design have been developed. For example, SEFSC has conducted in situ observations of red snapper behavior during shrimp trawling to aid in the design of more effective BRDs and has successfully led efforts to significantly reduce the bycatch of non-target species such as red snapper in the Gulf of Mexico shrimp fishery.

The development and use of improved TEDs is contributing to the recovery of sea turtles, especially Kemp's ridley in the southeastern region.

A recovery model for impacted subtropical seagrass habitats was developed and has been used successfully in court to demonstrate impacts to sanctuaries.

Research Priorities, FY 2004-2009:

- Continue investigations on the importance of environmental cues in the spatial orientation and migration behavior of sea turtles.
- Develop and test new gear technology and fishing techniques to minimize bycatch. The SEFSC continues to explore options to reduce bycatch and mitigate mortality of sea turtles and other non-target species captured in the distant water longline fisheries.

- Develop and test new gear technology and fishing techniques to minimize adverse impacts on EFH. The Center will continue to document the extent and assess the impact of various fishing gears on EFH in support of conservation and management activities.
- Promote efficient harvest of target species. The Center will conduct investigations into limited access options (e.g., individual transferable quotas (ITQs)) as resource management alternatives that aid increased harvest efficiency are continuing.

III. Research on the Fisheries

Recent Accomplishments:

Economic information, analyses, and evaluations were provided for numerous proposed fishery management actions in the southeast.

SEFSC developed and assisted in the collection of economic data through special surveys of the commercial snapper-grouper and mackerel fisheries.

SEFSC, in conjunction with academic economists, contributed to the development of random utility and contingent valuation models of the South Atlantic and Gulf of Mexico recreational fisheries.

SEFSC developed and implemented socio-economic data collection programs in the Atlantic snapper-grouper and Caribbean fish trap fisheries.

SEFSC hired two additional economists and an applied anthropologist to improve its research capabilities in the social sciences

Research Priorities, FY 2004-2009:

III.A. Social and economic research

- Design and implement procedures to collect socio-economic data on a routine basis. Data would be used to better determine the effects of regulation on commercial and recreational fishers.
- Develop better models of commercial and recreational fisheries to evaluate proposed management alternatives, including limited access systems.
- Estimate economic relationships such as demand curves, production functions, import supply curves, and recreational benefit functions needed to support the evaluation of management decisions.
- Collect socio-cultural data and develop analyses to describe the effects of fishery regulation on the lifestyles, social networks and communities and recreational fishermen and other users of living marine resources.

III.B. Seafood safety research

- Support research aimed at identifying and characterizing marine pathogens, especially viruses, in aquaculture shrimp products, and the extent of viruses in wild shrimp stocks.
- Continue to develop biological and chemical analytical methods for toxic contaminants (e.g., mercury), assess their presence in seafood, and define their impacts on marine ecosystems.
- Improve methods to detect, forecast, and evaluate the ecological significance of harmful algal blooms and their impact on fish stocks, marine mammals, and other protected species.

III.C. Marine aquaculture

- Develop the scientific foundation and technical guidelines for establishing ecologically responsible marine aquaculture.
- Continue to investigate the natural occurrence of shrimp viruses.

IV. Information Management Research

Recent Accomplishments:

SEFSC has developed and implemented a fully integrated Oracle-based fisheries logbook system.

Research Priorities, FY 2004-2009:

- Develop a fishery database and information management system that will allow the full use of information in support of effective fishery conservation and management.
- Fully integrate the logbook system with the regional permit database.
- Increase collection of observer-based data on bycatch and improved fishery-dependent data (e.g., via ACCSP's program with ASMFC).
- Secure access by constituents and the public to SEFSC information resources via web-based technologies.

NORTHEAST FISHERIES SCIENCE CENTER (NEFSC)

The Northeast Fisheries Science Center (NEFSC) has facilities in Woods Hole, MA; Narragansett, RI; Milford, CT; Sandy Hook, NJ (James J. Howard Marine Science Laboratory space rental from the state of New Jersey), and supports staff at the National Systematics Laboratory (housed at the Smithsonian Institution in Washington, DC.). The NOAA R/V *Albatross IV* and NOAA R/V *Delaware II*, berthed in Woods Hole, MA, support the majority of the Center's fisheries survey and research cruises.

Periodically, the NOAA R/V *Gordon Gunter* and NOAA R/V *Oregon II* (berthed in Pascagoula, MS) are utilized as supplemental sources for either surveys or research cruises. Private fishing vessels and academic research ships have been utilized on a periodic basis to support ecosystem surveys on the northeast continental shelf.

Two former Coast Guard Buoy-Utility Stern Loading (BUSL) vessels are being converted into inshore research vessels at the James J. Howard Marine Science Laboratory (R/V *Nauvoo* replaces R/V *Gloria Michelle*) and Milford Laboratory (R/V *Victor Loosanoff* replaces R/V *Shang Wheeler*). The R/V *Gloria Michelle* will be transferred to New Bedford, MA to support cooperative research between NEFSC, Massachusetts Division of Marine Fisheries, and the University of Massachusetts School of Marine Science and Technology (SMAST).



Northeast Fisheries Science Center Woods Hole Laboratory, Woods Hole, MA.

The NEFSC research activities runs the gamut from stock assessments on finfish populations during the Spring and Fall Bottom Trawl Surveys (conducted annually since the 1960s) to process-oriented research projects such as studying the impacts of global climate change on the coupling of zooplankton/cod and haddock larvae distribution and predation on Georges Bank. Additional fisheries surveys are conducted for ocean quahogs, surf clams and sea scallops, and grant funds are provided to support surveys of Gulf of Maine northern shrimp and finfish surveys in state waters. The Milford Laboratory conducts aquaculture research on molluscs and finfish; develops algal cultures as a food supply for molluscs; investigates harmful algal blooms (HABs) which pose a seafood safety threat; and investigates field stock enhancement approaches for bay scallops.



James J. Howard Marine Laboratory, Sandy Hook, NJ.

Long-term changes in the ecosystem supporting fisheries are monitored through surveys of the Northeast Shelf Large Marine Ecosystem (LME) and research is underway to convert such data into indices on the health of the ecosystem. Additional process-oriented research projects focus upon the effects of pollution on winter flounder; recovery of herring and Atlantic mackerel populations; trophic interactions between Atlantic mackerel, juvenile cod, and haddock; biological characteristics of selected shark species in the Northeast; recruitment processes of bluefish, effects of pollution on bluefish; fishing mortality of bluefish; field investigations on the effects of trawling on seabed habitats; and descriptions of Essential Fish Habitat (EFH) for most coastal finfish species. The Center also conducts social and economic research in support of the

fishery management process. The National Systematics Laboratory (NSL) provides taxonomic expertise on finfish, crustaceans, and squids.

Reliable information, critical to the development of regional Fishery Management Plans (FMPs) and subsequent amendments, and, ultimately, to the building and maintenance of sustainable fisheries, is produced through the Northeast Regional SAW process. This process is a cooperative effort of the NMFS/NEFSC and Northeast Regional Office (NERO), NEFMC, MAFMC, and the Atlantic States Marine Fisheries Commission (ASMFC). In the northeast, peer review of stock assessments is conducted twice per year within the Northeast Regional SAW process. The SAW process is guided by the SAW Steering Committee (directors of NEFSC and NERO, MAFMC, NEFMC, and the ASMFC), which determines the species to assess during a particular SAW cycle and establishes the assessment terms of reference. Each SAW cycle begins and ends with the meeting of the SAW Steering Committee and includes Working Group meetings (where analyses are prepared for review); a five-day Stock Assessment Review Committee (SARC) meeting (where analyses are peer-reviewed and advice for managers is developed); and a two- to three-session Public Review Workshop held during planned meetings of the MAFMC, NEFMC, and ASMFC. Participants in this process include NMFS scientists and managers; representatives from fishery agencies outside the region; MAFMC, NEFMC, and ASMFC representatives; state fishery agency representatives from within the region; academic and NGO participants; industry members; and occasionally experts from the international community. SAW meetings are open to the public and are widely announced. NEFSC personnel also participate in various committee meetings of the Regional FMCs and the ASMFC.

Much of the recent gear research in the northeast has been accomplished through grants, with NERO oversight. These grants have gone to fishers, or to organizations such as states and universities, which carry out the research with the help and cooperation of the fishing industry. The NERO Fisheries Engineering Group is also involved with data analysis for exempted fishery permits and fishway engineering for anadromous fish. Conservation engineering activities in the NERO have recently been concentrated on the problem of entanglement of large whales in fixed fishing gear (e.g., lobster traps and gillnet gear). A resolution to this problem will allow fishing to continue. The fishing industry aided this effort through its participation in the Gear Advisory Group to the Atlantic Large Whale Take Reduction Team to devise solutions, and by volunteering vessels and time for observations and testing. Also, NERO and the Center are collaborating on experiments using pingers and acoustic reflective nets as deterrents to marine mammal entrapment in gillnets. Cooperative research between the fishing industry, NEFSC/NER, and academia extends beyond gear research to include, the evaluation of the efficiency of the Center's surf clam/ocean quahog hydraulic dredge; supplemental surveys to the NEFSC bottom trawl surveys; collection of socioeconomic information on commercial/ recreational fishing operations; and gathering data on fish migration (tagging) and bycatch using commercial/ recreational vessels. Dr. Michael Sissenwine gave a presentation to the House Committee on Resources on cooperative research in the Northeast as a national model.

Recent Accomplishments and Research Priorities for FY 2004-2009

I. Research to Support Fishery Conservation and Management

Recent Accomplishments:

Rates of growth, development, and survival have been estimated for the larval goosefish.

Data have been gathered on the timing and location of goosefish spawning.

Rates of growth, development, survival, and how these vary with water temperature, have been estimated for the egg, larval, and juvenile stages of summer flounder and winter flounder.

The NEFSC has demonstrated that the technique of using scale texture for sexing winter flounder is invalid.

Winter flounder courtship and spawning behavior has been described relative to estuarine habitats.

Measures of egg quality and parental effects on offspring condition have been quantified for summer flounder and winter flounder. The influences of the timing and location of spawning of summer flounder on offspring fitness have been estimated.

Fieldwork in the U.S. GLOBEC program on Georges Bank has been conducted. The program is investigating the environmental and biological processes controlling the reproductive success of the cod and haddock stocks on the Bank.

Development of a micro-constituent technique for stock identification of bluefin tuna and other species was completed.

NEFSC demonstrated that diet influences otolith micro-constituent composition in young-of-the-year bluefish.

The oceanographic conditions on the Northeast Shelf were measured and the inter-annual variability was documented in a report each year. The data were used in stock assessment activities and available to the scientific community via the World Wide Web.

NEFSC completed a study of diets of 16 fish species in lower Hudson-Raritan Estuary, as compared to other Middle Atlantic areas.

NEFSC completed the second year of a sampling program in the inner New York Bight and lower Hudson-Raritan estuary studying the effects of environmental/habitat variables on settlement and early post-settlement processes of local fish species.

First estimates of rates of hooking mortality for bluefish are being completed.

Effects of sediment contamination on predator-prey interactions are being completed.

Several presentations have been made on the effects of bottom trawling on the seabed at Georges Bank.

Surveys collecting *in situ* video observations of the sea floor and conducting trawls in the mid-Atlantic Bight have been useful for assessing the effects of bottom trawling on tilefish habitat.

Hydroacoustic survey techniques have been developed for pelagic fish species and are being used in stock assessments for Atlantic herring.

The NEFSC Fisheries Observer Program conducted detailed monitoring of pound nets in Chesapeake Bay during the spring of 2002 and 2003 for sea turtle entanglements. After monitoring nets in the entire Bay, areas of great concern were identified by recording 7 entanglements in 2002 and 17 in 2003. This research has led to management actions to prevent further mortality of endangered and threatened sea turtles.

Bigelow and Schroeder's "*Fishes of the Gulf of Maine*", edited by Bruce B. Collette and Grace Klein MacPhee, was published by Smithsonian Institution Press.

Ground Fish Assessment Review Meeting (GARM) was held in October 2002 to review the trawl warp impact on the resource surveys aboard the R/V *Albatross IV* from Winter 2000 to Spring 2002.

Twelve Center scientists and six outside experts released a summary report that re-evaluated the potential growth, achievable population sizes, and sustainable fishing rates for major groundfish stocks in the Northeast (to address shifting baseline phenomena).

In February 2003, an external peer review was conducted on the NEFSC's stock assessment approaches as a prelude to developing Amendment 13 for the Multispecies Groundfish FMP.

In 2001, the report "*Marine Angler Expenditures in the Northeast, 1998*" estimated \$4.5 billion in recreational fishing equipment and trip expenditures by saltwater anglers in ten northeastern states.

In 2001, the new Fisheries Scientific Computing System (FSCS) was introduced on our fisheries research vessels (*Albatross IV* and *Delaware II*) which provided researchers immediate access to our survey data.

NEFSC scientists participated in the History of Marine Animal Populations (HMAP) project which was funded by a \$1.2 million grant from the Alfred P. Sloan Foundation in New York. This project contributes to the Census of Marine Life (CoML) program.

Biological parameters that potentially regulate foraging competition in juvenile bluefish and striped bass were identified.

A series of 30 EFH Source Documents, summarizing life history, habitat, and distribution/abundance information, was provided to NEFMC and MAFMC.

A study of functional equivalence of marshes replanted after EXXON Bayway Oil Spill in Arthur Kill (NY/NJ) too oiled, but unrestored, marshes and control marshes was completed.

The potential predation risks of juvenile summer flounder and winter flounder in inshore habitats were quantified.

NEFSC demonstrated that nominal habitat classifications are inadequate for defining and studying the functional value of those habitats.

NEFSC has conducted studies which demonstrated that habitats are dynamic, defined by complex interactions of changing environmental conditions, and yielding a space favorable to growth and survival that continually expands, contracts, and changes position.

Environmental conditions and physical habitat within a shallow coastal nursery area in Connecticut that supports young tautog were characterized. The distribution and abundance of these fish has been described and preliminary GIS-based spatial maps have been created. Young tautog have been marked with coded wire tags in an effort, through mark-recapture, to determine individual growth rates, population size, and the extent of site-fidelity. Diets of young tautog and food habits of predators have been investigated. These efforts will be valuable in future attempts to release hatchery-reared tautog as they become available from the Milford Aquaculture Program.

The effects of egg incubation temperatures on the development and survival of summer flounder, winter flounder, windowpane, cod, and haddock have been quantified through laboratory experiments.

A study was completed that indicated that the re-suspension of contaminated sediments is the dominant process in distributing contaminants in the Hudson-Raritan and Navesink estuaries.

The uptake of trace metals and organic compounds into mussels from Arthur Kill sediments, including those tainted by oil spills, was investigated.

NEFSC Ref. Doc. 02-11 on the status of the Northeast U.S. Continental Shelf Ecosystem provided an overview of the results from the NEFSC's monitoring programs/resource surveys and will serve as the base for supporting the Center's ecosystem-based approach for fisheries management (EbM). A number of peer-reviewed journal publications resulted from this information synthesis endeavor.

A paper published in Limnology and Oceanography described the distribution of chlorophyll (from ocean color) and sea surface temperature (SST) off the Northeast coast that will provide the basis for estimating primary production on the shelf. This will support the EbM program.

Ocean Exploration funding has been utilized to examine deep sea nekton/epibenthic biodiversity at the Bear Sea Mount and Mid-Atlantic Ridge in support of the Census of Marine Life (CoML).

The Rutgers University/NOAA Cooperative Marine Education and Research (CMER) Program has supported research on the effects of bottom roughness on surf clam larval settlement and recruitment.

The University of Massachusetts/NOAA CMER Program has supported research on the use of living marine resources (LMRs) for subsistence utilization and the entry points for heavy metal contaminants into the marine food chain.

Research Priorities, FY 2004-2009:

I.A. Biological research concerning the abundance and life history of fish stocks

- Continue to develop improved biological parameter estimates.
- Determine biological, environmental, and habitat processes controlling the reproductive success of important fishery resources.
- Expand research in the development of micro-constituent chemical analysis techniques for stock identification.
- Continue and expand cooperative research activities with the fishing industry to routinely collect environmental and biological data for improved monitoring of the ecosystem.
- Transition bio-physical models developed as part of research programs to operational tools for use in support of management decisions.
- Continue field and modeling research activities to better understand the influence of environmental variability on lower trophic level productivity and fish recruitment.
- Conduct studies to document and understand the behavior and movement of fish in areas of critical habitat.
- Continue to monitor oceanographic and biological conditions on the Northeast Shelf and document ecosystem variability in order to determine its role in the recovery and sustainability of depressed fish stocks.
- The NEFSC is developing a pilot project for an ecosystems-based fisheries management approach based upon the observed shift in the early 1980's from a demersal-dominated fish community to a pelagic-dominated community.



Fall groundfish survey in the Gulf of Maine is conducted on R/V Albatross IV.

- The Hydroacoustics Team will develop acoustic scattering models to improve population estimates and examine the applicability of advanced technologies, such as broadband and multibeam acoustic systems.
- Cooperative research tagging projects for black sea bass in the Southern New England (SNE) and MAB areas and cod in the Georges Bank (GB)/Gulf of Maine (GOM) regions will expand our knowledge of fish migration and demographics for these species.
- An outgrowth of the GARM workshop was the creation of a joint NMFS/Industry committee to provide oversight for the bottom trawl resource surveys.
- On outgrowth of the stock assessment peer review is continuing investigations of the appropriate assessment methodologies for GB/GOM cod stocks and SNE winter flounder and the appropriate uses of Ricker stock-recruitment models.

I.B. Social and economic factors affecting abundance levels

- The UMass/NOAA CMER Program is supporting a new research project on the factors constraining recreational fishing activities.
- The bluefish/striped bass interaction project for the Mid-Atlantic Bight (MAB) has embarked upon a new research direction to understand bluefish dynamics at large spatial scales in order to support management/user information needs. This effort is coordinated by the Rutgers/NOAA CMER Program.
- Ocean exploration funding will continue cruises for delineating deep sea biodiversity of nekton.
- Completion of Large Marine Ecosystem (LME) volumes will continue and website/maps will be updated.
- Completion of manuscript on decadal changes in ocean color measurements on the Northeast Continental Shelf using the CZCS and SeaWiFS satellite sampling periods.
- UMass/NOAA CMER Program is supporting a new project examining sea scallops/starfish predator-prey interactions on Georges Bank.

I.D. Identifying, restoring, and mapping of essential fish habitat (EFH)

- Identify and provide EFH information as required by the MSFCMA for FMPs for the NEFMC and ASMFC.
- Continue to conduct research to determine the functional value to estuarine and nearshore habitats, including restored sites, to the sustainability of fishery resources.

- Continue to improve our GIS capabilities in order to map seabed habitats and indicate EFH with respect to various human-activities.
- The Rutgers/NOAA CMER Program Director has received extramural grant support to examine the bio-availability of dissolved organic nitrogen (DON) to help elucidate its role in coastal eutrophication. A biocomplexity grant from the National Science Foundation is being used to examine the bottom-up and top-down processes controlling the microbial degradation of organic matter in estuarine sediments.

I.E. Impact of anthropogenic factors and environmental changes on fish populations

- Conduct research to determine the effects of climate variability on the sustainability of coastal and pelagic fishery resources.
- Investigate the transfer of contaminants within estuarine systems and their effect on the growth and sustainability of fish populations.
- Continue to investigate the effect of fishing activities on seabed habitats and EFH.

II. Conservation Engineering Research

Recent Accomplishments:

Through the recently established NEFSC Office of Cooperative Programs Coordination, approximately 1,600 research fishing days were conducted since the program's inception in September 2000. This multi-faceted program is designed to explore ways to improve data upon which fishery management decisions are made as well as to improve communications between fishers, scientists, and fisheries managers. One of the key elements of this program is in the area of conservation research (i.e., mesh selectivity, bycatch discard reduction, harvest efficiency, and gear development).

The NEFSC Fishery Observer Program has made recent strides in the development and deployment of more selective fishing gears by placing scientific observers aboard commercial vessels. Specifically, in the Gulf of Maine northern shrimp fishery, the Nordmore grate was tested and subsequently implemented as a method to reduce the take of juvenile groundfish. Sea sampling was used in the initial gear trials, and the at-sea observer program continues to monitor the fishery following full implementation of the grate requirement. The fishery observer data indicate significant reductions in finfish bycatch after introduction of the Nordmore grate in the shrimp fishery. Although reduced catches of important groundfishes are in part due to their decreased abundance in recent years, the grate has been effective in reducing the fraction of finfish caught in this fishery, thereby reducing fishing mortality on young groundfish.

Similar studies evaluating the effectiveness of acoustic alarms to deter harbor porpoise from entering groundfish sink gillnets have also been conducted through the Fishery Observer Program. These studies involved alarm-equipped and control nets, fished in the vicinity of harbor porpoise aggregations. Results from this work are currently being evaluated to determine

the efficacy of this method in reducing harbor porpoise mortalities. Additionally, at-sea observers have been used in other gear-related studies such as in the New England groundfish fishery to evaluate the effectiveness of changes in trawl mesh size.

Center scientists are also involved with the development of gear based solutions for the reduction of sea turtle takes in commercial fisheries. Two projects are currently underway, including the use of a chain mat on scallop dredges to reduce turtle bycatch in the scallop fishery and the development of a turtle-proof whelk pot to reduce entanglements. Both of these projects are cooperative efforts with industry and the Virginia Institute of Marine Sciences. A third cooperative project to develop turtle-safe pound net leaders is in the development stage.

Research Priorities, FY 2004-2009:

- Conduct research to develop and enhance gear performance and characteristics.
- Conduct research aimed at reducing bycatch and marine mammal mortalities.
- Conduct studies to evaluate the effects of gears on habitats.

III. Research on the Fisheries

Recent Accomplishments:

The NEFSC has recently completed development of a New England-wide Input-Output model in collaboration with the Woods Hole Oceanographic Institute's Marine Policy Center. This model is used to assess distributional impacts of fisheries regulations.

The NEFSC conducted collateral research with the Massachusetts Institute of Technology's Center for Marine Social Sciences (CMSS) to collect socio-economic data on fishers and fisheries-dependent communities.

The NEFSC has conducted Vessel Cost and Earning Surveys for all major fisheries in the region. These "snap-shot" surveys contributed to the design of the coast-wide pilot program for social science data used by the Atlantic Coast Cooperative Statistics Program (ACCSP). Data collection is now being collected on a continuing basis through the sea sampling program.

The NEFSC has produced a variety of socio-economic publications on the fisheries to inform resource managers and the public. These works address such issues as property rights, allocations between recreational and commercial fisheries, rent-seeking behavior in fisheries, models of recreational fisheries, tests of fishermen's predictions of management impacts and estimates of forgone national benefits as a result of shortcomings in the management of groundfish. Additionally, in support of two regional FMCs, the NEFSC has provided RIR/FRA analyses for 17 FMPs and numerous amendments/framework actions.

The NEFSC's Office of Marine Ecosystem Studies has been active in the monitoring and assessment of changes within the U.S. Northeast Shelf ecosystem in relation to the recovery of

depleted demersal fish stocks, including cod, haddock, and yellowtail flounder and the unprecedented population explosion of pelagic herring and mackerel stocks.

Several United Nations agencies are collaborating with the NMFS Office of Science and Technology and Fishery Centers to introduce ecosystem-based assessment and management practices leading to the recovery of depleted fish stocks in Asia, Africa, Latin America, and Eastern Europe. A five module strategic approach developed and tested by the NEFSC has been introduced to coastal countries bordering LMEs of the Yellow Sea (China and Korea), the Benguela Current (Angola, Namibia, South Africa), the Guinea Current (Benin, Cameroon, Ghana, Ivory Coast, Nigeria, and Togo), and Baltic Sea (Denmark, Finland, Germany, Sweden, Estonia, Latvia, Lithuania, Poland, and Russia). The five modules provide advanced methodologies for monitoring and assessing the: (1) productivity, (2) fish and fisheries, (3) pollution and health, (4) socio-economics, and (5) governance of the LMEs.

The NEFSC has conducted several studies on the effects of buyout programs in the Northeast regions including an assessment of buyout program effectiveness and improvements in buyout program design.

The NEFSC has provided personnel who organized a national Communities Workshop attended by NMFS, other federal agency and academic social scientists to explore issues related to National Standard 8 of the 1996 Sustainable Fisheries Act as well as other legally required social analyses such as Social Impact Assessments. A Sociocultural Practitioners' Manual resulting from this Workshop, co-authored by NEFSC personnel, is in the editing phases.

The NEFSC has provided personnel to create and update content for the Community Impact Analysis page hosted by HQ's Office of Science and Technology.
(<http://www.st.nmfs.gov/st1/econ/impact.html>).

The NEFSC created and analyzed a survey of vessel owners and crew who participated in a buyout, creating a publication that is easily accessible to the public by mail or on the web
(<http://www.nefsc.noaa.gov/read/socialsci/survey-initiative/>).

The NEFSC has developed methods for estimating fishing capacity and fishing vessel efficiency which have been used to assess fishing capacity in the Northeast region and were accepted as the standard for capacity measurement in other regions.

The NEFSC has developed math programming models to evaluate effort redirection in time and space in response regulatory measures that may vary by region or season. This model was used the primary basis for biological and economic impact assessment for groundfish and has been applied to evaluate essential fish habitat alternatives for several Mid-Atlantic plan amendments.

Grants from the Global Environment Facility have been allocated over the past five years to support the LME projects. In each of the LME projects, joint international surveys are carried out measuring the effects of changing ecosystem states on the recovery of depleted fish stocks and the long term sustainability of biomass yields, ecosystem health, and socio-economic benefits to the coastal communities. Participating countries have created, under the United

Nations Convention on the Law of the Sea (UNCLOS), Commissions and other joint institutions to serve as governance bodies and to initiate more sustainable ecosystem-based management protocols than have been generally initiated and practiced during the past half century.

Sampled and characterized nearshore rocky-vegetated and sand habitat types in studies prerequisite to stock enhancement trials with tautog and/or black sea bass.

Developed a genetic line of phenotypically distinct bay scallops with striped shells for stock enhancement trials in the Niantic River.

Completed a year-long monitoring of scallop larvae, water, and feed for microbial pathogens and provided advice on disease avoidance in aquaculture systems.

Evaluated prevalence of blood-borne bacteria in a cooperative study on caged lobsters in stressed environments.

Co-chaired “Workshop on Domestication of Molluscan Shellfish”, with French colleagues, in La Tremblade, France, to develop implementation plan for NOAA-IFREMER Bilateral Agreement on Oceanography project.

Co-chaired a Genetics Theme Session with Danish colleagues for the ICES Conference in Copenhagen,

Completed overview of historical accounts of fish kills in coastal New Jersey waters; published findings as NEFSC Reference documents.

Completed development of flow-cytometric methods for evaluation of morphology and function of hemocytes for the eastern oyster, in collaboration with French colleagues; submitted three articles for publication in peer-reviewed journal.

Started new research initiative on use of heterotrophic protists in aquaculture food chains; in collaboration with other Milford personnel and CMER-funded university researchers.

Completed initial exposures of pathogen-infected lobsters to four environmental stressors and analyzed lobster death rates associated with bacterial growth rates.

Completed experimental study demonstrating unexpected nutrient limitations in large-scale microalgal cultures and developed strategies to mitigate limiting factors.

Demonstrated for the first time effects of harmful algae upon the cellular immune response of oysters and scallops, in collaboration with French colleagues.

Completed experimental studies of trophic interactions between bivalve and pulmonate mollusks, and toxic *Alexandrium* species, as both vegetative and cyst stages.

In October 2002 the EPA report EPA/600/R-02/079 on the Waquoit Bay Watershed Ecological Risk Assessment project examined the relationship between land use activities on upper Cape

Cod, nitrogen enrichment of the bay waters, the loss of eelgrass beds and collapse of the bay scallop harvest.

The University of Rhode Island (URI)/NOAA Cooperative Marine Education and Research (CMER) Program has helped support the Narragansett Bay Cooperative Study Project which examines the physical and biological processes controlling the productivity in the bay.

Research Priorities, FY 2004-2009:

III.A. Social and economic research

- Social science staff will develop a strategic research plan to improve the social science information available to fishery managers. This plan will assess existing sources of data, identify research needs, and determine a strategy for achieving these needs to include a combination of out-sourced and in-house research. Some tasks already underway include:
- Work with area expert to examine the role of Environmental Justice (E.O. 12898) issues as they relate to fishing communities in the Northeast.
- Work with area experts to identify and explore proactive community-based initiatives that encourage fishery conservation in the Northeast and the role government/fisheries management can play in providing an enabling environment for such initiatives.
- Develop social indicators and minimum data elements to be incorporated into other National and regional efforts, such as the ACCSP database, the observer program and National data collection efforts.
- Work with NMFS headquarters, regional experts, community leaders and school children to help create a database of traditional knowledge in Maine, as part of a pilot project that may be expanded nationally.
- Continue to develop guidance on National Standard 8 and on social impact assessments (SIAs). This includes examining approaches to rapid assessment techniques and institutions as well as establishing coastal cooperation in the supply of updated information relevant to SIAs on a continuing basis.
- Investigate and develop design features to mitigate perceived failures of individual fishing quota (IFQ), ITQ, and CDQ fishery regulations.
- Continue the development of ongoing coast-wide cost and earnings data collection systems. This research includes the design of a fixed cost sampling protocol and the exploration of wide-scale observer-supplied economic data systems.
- Continue the development of a socio-cultural information gathering system sufficient for National Environmental Policy Act, National Standard 8, and SIA requirements for

fisheries, marine mammals, endangered species, critical habitat for designated species, and EFH designations.

- Conduct additional research into multi-species management options incorporating various levels of constituent species. Research will focus on differential area treatment of gears, vessels, and effort based on habitat and fishing mortality considerations as well as impacts of variously defined MPAs.
- Conduct further exploration of applicability and utility of GIS information on economic and socio-cultural assessments of area-based management options including development of socio-economic and governance modules for LMEs.
- Continue research efforts for price models, bio-economic models, rapid social assessments techniques, rights-based fishing modes, annual round fisheries, and other issues central to improving approaches to management and the design and assessment of alternatives. Of particular concern is the coming need for the estimation of non-use benefits and cost minimization research for EFH, ESA, and MMPA issues.
- Extend input-output models to mid-Atlantic states for the management of recreational fisheries.
- Examine the role of the processing sector in New England and mid-Atlantic communities. Research will be used to improve socio-cultural data bases as well as refine regional input-output models.
- Integrate NEFSC population dynamics simulators with economic optimization models to examine potentially superior exploitation trajectories for groundfish.
- Develop predictive models of trading of days-at-sea.
- Develop spatial dynamic models to assess optimal design of approaches to essential fish habitat protection including a comparison between piecemeal and zoning approaches.
- Extend previous research on risks at-sea.
- Examine the relationship between fish landings, imports, resource conditions and processing capacity in New England.

III.C. Marine aquaculture

- Continue the development of the microalgal greenhouse-recirculating seawater nursery system, using technologies currently in place, to identify most critical needs for further development.

- Determine the feasibility of aquacultural pilot-scale hatchery production of black sea bass juveniles and adults.
- Evaluate the potential value of using selectively-bred bay scallops with distinct shell markings in field stock enhancement efforts.
- Determine the importance of unusual sterols in harmful microalgae, in terms of nutritional and toxic effects upon bivalve mollusks and crustaceans.
- Explore the extent to which harmful algal blooms affect the immune system capability of bivalve mollusks and the importance of these effects in the susceptibility of mollusks to environmental, pathogen, and parasite stresses.
- Define the role of nearshore hard-substrate reefs as habitat for young fish.

IV. Information Management Research

Recent Accomplishments:

NEFSC oceanographic data sets are being served through a distributed oceanographic data system (DODS) compliant server. In addition, data collected as part of the U.S. GLOBEC program on Georges Bank are being served through the GLOBEC data system, which is a DODS compliant system.

Research Planning and Coordination (RPAC) Group utilizes Project, Planning and Tracking (PPT) System for linking planned program activities with accomplishments (milestones and events).

Data Management Systems (DMS) Group developed the PPT System.

RPAC operates an Extramural Proposal Tracking System that informs scientists of funding opportunities and then oversees the endorsement/review process for submitted proposals. RPAC provides an annual report to the Science and Research Directorate on this program.

Publications Office ensures internal review of publications for science and policy issues, plus provides technical editorial support.

Research Priorities, FY 2004-2009:

- Continue to develop and expand DODS compliant client and server libraries to support Internet access to NODC oceanographic data sets.

- Continue ESDIM Funded projects to rescue 106-year plankton and temperature time series from 1840-present.
- Integrate acoustical data from echo founders with biological and oceanographic data into a relational database with GIS capabilities to support hydroacoustics research program.
- Use PPT system to support information input to Annual Operating (AOP) system, while DMS provides technical support for PPT.
- DMS provides technical support for databases used by Center scientists: FSCS, Biological Sample Monitoring Data Base System (BSMDBS), Scallop Experimental Fisheries Data Base System (SEFDBS), Marine Mammal Stranding Data Base System (MSDBS), Commercial Fisheries Data Base System (CFDBS), Food Habits Data Base System (FHDBS), Observer/Sea Sampling Data Base System (OBDBS/SSDBS), etc.
- DMS converts Center databases to the Oracle Relational Database Management System (RDBMS), including survey databases, food habits database system, and age data entry system.
- DMS will continue working on a commercial fisheries database system (CFDBS) allocation scheme for 1994-1999 commercial fisheries catch/effort data.
- DMS is developing a prototype data set for the ACCSP in an intermediate file transfer format.
- The Research Communication Office within the Operations Management and Information Services (OMI) unit provides oversight for library services from a contract with the Marine Biological Library/Woods Hole Oceanographic Institution (MBL/WHOI) Joint Library.

PACIFIC ISLANDS FISHERIES SCIENCE CENTER (PIFSC)

The Pacific Islands Fisheries Science Center (PIFSC) conducts multi-disciplinary basic and applied research on insular and oceanic pelagic living resources and fisheries of the Pacific Islands and central Pacific. The PIFSC headquarters are located in Honolulu, Hawaii, on the University of Hawaii at Manoa campus and has a shoreside research facility at Kewalo Basin. These facilities house the staff of over 160 that are employed by the PIFSC and its University partner, the NOAA Joint Institute for Marine and Atmospheric Research (JIMAR). The primary platforms supporting PIFSC field activities include the NOAA ship *Oscar Elton Sette* and chartered vessels from the commercial industry. Fisheries research activities at the PIFSC support the scientific, statistical, and economic needs of the Western Pacific Region Fisheries Management Council (WPRFMC) and international commissions for the management and conservation of large highly migratory pelagic species (HMS), including the Commission on the Conservation of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean

(MHLC), the Standing Committee on Tuna and Billfish of the Secretariat of the Pacific Community (SCTB), and the North Pacific Interim Scientific Committee for Tuna and Tuna-like Species (ISC). Collaborative and cooperative research partners include other Federal and State of Hawaii agencies, academic institutions, foreign research institutions, government agencies of American Samoa, Guam, the Commonwealth of the Northern Mariana Islands, and the public sector including the commercial fishing industry, seafood markets, and recreational and environmental interests, including NGOs. While not outlined here, a broad range of research focused on protected resources not related to fisheries are also conducted at the PIFSC.

The PIFSC conducts biological, ecological, and economic research on the following fishery resources that fall under active fishery management plans:

- large pelagic fishes of the Pacific Ocean (including tunas, billfishes, sharks, and a number of other incidentally caught but commercially important species)
- crustaceans of the Pacific Islands deep slopes (lobsters and shrimp)
- bottomfish and seamount groundfish of the central Pacific
- precious corals of the central Pacific
- coral reef ecosystems of the central Pacific

In addition, from a marine ecosystem standpoint, all of the PIFSC fisheries programs rely on information about the physical environment in the western and central Pacific Ocean. To this end, satellite remotely sensed ocean and atmospheric data, ocean circulation models, information from research cruises, and fisheries data are used to advance our understanding of the dynamic physical and biological ecosystems found in the Pacific region.

Organizationally, fisheries research at the PIFSC is generally carried out by four of the Center's research divisions: the Coral Reef Ecosystem Division (CRED), the Ecosystems and Oceanography Division (EOD), the Fish Biology and Stock Assessment Division (FBSAD), and the Fishery Management and Performance Division (FMPD). The CRED conducts multidisciplinary ecosystem-based research and monitoring that provides the scientific basis for effective management and conservation of coral reef ecosystems in the U.S.-affiliated islands of the central and western Pacific Ocean. Specific research activities include: 1) ecological assessment and monitoring to quantify and document spatial and temporal changes in the health of coral reef living resources due to natural or human-induced impacts; 2) habitat mapping and characterization to define and understand the dynamics of habitat-ecosystem-resource linkages; 3) monitoring of oceanographic processes affecting reefs to monitor conditions that influence coral reef ecosystem health; and 4) reef restoration through the assessment, monitoring, and mitigation of the effects of marine debris on coral reef ecosystems. Complementary applied research include: evaluating the effectiveness of marine protected areas (MPAs), evaluating impacts of fishing gear on essential fish habitat, and improving assessment and monitoring techniques for commercial bottomfish populations.

The EOD conducts research aimed to advance our understanding of the structure and dynamics of marine ecosystems in the Pacific Islands region and the broader North Pacific. Research focuses on: 1) the role of living resources in the ecosystem and 2) how these resources might respond to change, both on the local scale (e.g., predators or prey availability) and on broader

time and space scales (e.g., ocean climate change). The EOD's multidisciplinary projects allow for collaborative research with other Center Divisions, agencies, and academia, and address ecosystem, environment, and anthropogenic impacts for a range of species including the Hawaiian monk seal, several species of sea turtles, and highly migratory species including tunas, billfishes, and other incidentally harvested species.

The FBSAD conducts state-of-the art research related to the population biology, stock assessment, ecology, and life history of exploited resources and associated species (e.g., prey, bycatch, and protected species) in the central and western Pacific. FBSAD integrates biological, ecological, oceanographic, and economic data to advance stock assessments and to advise resource management at both species and ecosystem levels while addressing mandates of the MSFCMA, ESA, MMPA, and the Migratory Bird Treaty Act. Research programs emphasize population modeling, resource survey cruises, experimental fishing, determination of vital rates and other life-history parameters, environmental physiology, distributional ecology, and mitigating fishery interactions with protected species.

The FMPD is the focal point for fisheries dependent data collection and economic and operational research for the PIFSC. This Division collects, quality controls, and processes fishery-dependent information (i.e., logbooks), issues quarterly and annual reports (including longline, bottomfish, and lobster), and conducts socio-economic research on Federally managed fisheries. Also residing in FMPD is the Western Pacific Fisheries Information Network (WPacFIN) that collects and processes Pacific Islands' agencies data (Territories of Guam and American Samoa, Commonwealth of the Northern Mariana Islands, and State of Hawaii) and also provides technical support to develop and implement appropriate data collecting, processing, summarizing, analyzing, and report-generating systems for these island agencies.

Recent Accomplishments and Research Priorities for FY 2004-2009

I. Research to Support Fishery Conservation and Management

Recent Accomplishments:

Several life history studies involving juvenile swordfish, *Xiphias gladius*, have been completed. These studies include an otolith-based age and growth study using scanning electron microscopy (SEM) that will help to corroborate estimates of age-1 individuals derived from anal fin ray cross-sections and a calibration experiment among four international Pacific fisheries laboratories for processing and reading of fin-ray cross sections to determine growth rates. Also completed was a project to assess the ability to detect geographically distinct natal sites of juvenile swordfish in the Pacific using geochemical elemental fingerprinting. These results are a first step in determining our future ability to determine natal origin of adult swordfish based on analyzing the elemental chemistry of the juvenile portion of the otolith.

The PIFSC and the SWFSC have successfully collaborated on a billfish egg and larvae project which has culminated in the ability to identify istiophorid larvae and billfish eggs of all six Indo-Pacific billfish species found in Hawaiian waters. Using genetics (PCR identification) techniques developed at the SWFSC and refined at sea on PIFSC research cruises, this technique

provides for near-real time identifications while at sea and now allows field researchers the ability to adapt subsequent sampling protocols in order to better define the location, spatial extent, and associated habitat of specific billfish species.

Completed fecundity and size-at-maturity studies for spiny and slipper lobsters in the Northwestern Hawaiian Islands (NWHI) revealing temporal changes in the reproductive traits of spiny lobster. Size-specific increases in fecundity and egg size were observed in the most recent estimates as compared to historical estimates and fecundity increases were consistent with decreases in median body size at sexual maturity. These findings lend credence to the need to periodically reevaluate the reproductive responses of exploited lobster populations.

Supplemental spiny lobster tagging experiments were continued at Necker Island (ca. 14,000 lobsters tagged) to obtain independent estimates of mortality, growth, abundance, and movement, to advance population modeling and resource assessments. Feasibility experiments to assess the utility of a stationary underwater camera system to qualify and quantify potential impacts of lobster trapping on coral reefs have also been completed.

Studies on the population status of several HMS were completed that provides up-to-date information for the management of the Hawaii-based longline fishery. Assessments of North Pacific swordfish and blue shark indicate that both populations are sustainable given current fishing pressure; however, a Pacific-wide blue marlin assessment indicates that the population may be close to a fully exploited state.

PIFSC scientists continue research utilizing electronic tags to improve our understanding of the ecological, migratory and post-release survival of longline caught fish. Pop-up satellite archival tags (PATs) have been deployed on blue sharks, bigeye tuna, swordfish, opah or moonfish, and albacore tuna. The PAT technology has provided excellent data on fine-scale vertical movements, and geolocation estimates have pioneered the use of a state-space Kalman filter to estimate light-based geolocation errors, horizontal movement parameters, most probable tracks and residence times.

A recent multi-level economic multi-objective programming model (MMPM) has been developed for the Hawaii fisheries and will be used to analyze the economic impacts of time-area closure policies.

Generalized additive models (GAMS) have been developed using detailed catch and set observations gathered from Pacific Islands Regional Office observer program to assess the impact of time-area closure alternatives in the Hawaiian longline fishery. In particular, the models were used to assess the effectiveness of the time-area closure imposed on the longline fishery and are being used in litigation concerning the impact of the Hawaiian longline fishery on sea turtles.

Recently completed analysis on the migration pathways and foraging habitat of loggerhead and olive ridley sea turtles will help in identifying time, area, and gear restrictions that will reduce incidental catches in the fisheries where sea turtles are caught incidentally, particularly the Hawaiian longline fishery for tuna.

Surveys conducted with the National Undersea Research Program (NURP), Hawaii Undersea Research Laboratory (HURL) submersibles and ROV have enabled description of essential fish habitat for Hawaiian bottomfish and evaluate the effectiveness of bottomfish RFAs. These technologies have also supported PIFSC research on the density, size structure, and associated fish assemblages of deepwater coral communities and have led to findings of the ecological importance of deepwater corals as monk seal critical forage habitat.

Baseline ecological surveys of fish, corals, algae, and other invertebrate diversity and abundance have been completed for selected areas of the U.S. Line and Phoenix Islands, American Samoa, and the NWHI, using separate but complementary techniques of Rapid Ecological Assessments (REAs) and towed diver surveys. These surveys also resulted in the first, and extensive, observations of widespread mass coral bleaching in the NWHI.

An acoustic benthic habitat characterization system capable of performing high-resolution mapping in coral reef habitats was developed, providing a very effective means for extending habitat characterization to deeper areas that are not suited to observations by divers or by satellite.

More than 100 tons of marine debris was removed (in summer 2003 alone) by a multi-ship, multi-agency 4-month cooperative effort at Pearl and Hermes Atoll and Midway Island in the NWHI.

Research Priorities, FY 2004-2009:

I.A. Biological research concerning the abundance and life history of fish stocks

- Conduct peer-reviewed assessments and statistical analyses on stocks of insular and pelagic species.
- Conduct research to better understand the stock dynamics and influence of environmental conditions on pelagic and NWHI insular stocks.
- Develop new methods of stock assessment for application to data-poor bottomfish species.
- Develop a comprehensive insular resource survey using chartered commercial fishing and research vessels for the Hawaiian Archipelago.
- Assess the connectivity of spatially structured insular populations in the Hawaiian Archipelago.
- Develop and implement an international tagging program for highly migratory species in the Pacific Ocean to trace their movements between fisheries and countries, and provide biological data to advance stock assessments.

- Develop a new generation of stock assessment models for stocks of highly migratory species and coastal pelagic species in the Pacific Ocean and the state-of-the-art software to support them, using modern statistical optimization techniques, Bayesian methods, simulation, and object-oriented programming languages.
- Use pop-up satellite tags to identify forage and migration habitats of exploited species and protected resources in the central and western Pacific.
- Continue analysis of experimental longlines to understand HMS habitat requirements and options for bycatch reduction.
- Develop a spatial and temporal model to predict the catch of bigeye and yellowfin tuna in the Palmyra region.
- Assist local resource management agencies develop systems of marine protected areas (MPAs) appropriate for each island's marine ecosystems.
- Develop methods to assess the efficacy of various MPAs, ecosystem pre-serves, and other time-area closures in restoring fish stocks and increasing sustainable yields.
- Examine the role of ocean circulation on larval transport and recruitment of fish, corals, algae, and crustaceans with the goal of improved understanding of ecosystem dynamics and an ability to evaluate the effectiveness of no-take MPAs as refugia and replenishment areas.

I.B. Social and economic factors affecting abundance levels

- Expand sociological and economic research and incorporate results into the fishery management process (EIS, EA, NEPA).
- Develop behavioral models of economic incentives affecting the level and allocation of fishing effort in FMP fisheries.
- Evaluate the regulatory impacts of recent and potential area closures regulatory policies, using the updated empirical model. All parameters for fish stocks, catch rate, and prices will be updated using the latest catch, effort and price data (1998-2002).
- Enhance the empirical model and extend the application to include other fisheries (troll, handline, recreational fishing), which could enable an estimation of the change in the tradeoff value between small boats and longline fishery due to regulations.
- Conduct RIRs and RFAs for management actions being considered for all FMP fisheries.
- Evaluate alternative objective functions using different constraints to examine alternative economic assumptions for the Hawaii longline industry (i.e., competitive equilibrium

where resource rent is dissipated vs. effort allocation by a sole fishery regulator where resource rent is maximized).

I.C. Interdependence of fisheries or stocks of fish

- Develop integrative oceanic environmental indices to improve understanding of how environmental variability affects fish stocks.
- Extend analysis of factors affecting longline-turtle and longline-sea bird interactions to include more detailed oceanographic, tagging, and behavioral analysis.
- Evaluate the foraging ecology of the Hawaiian monk seal in terms of its use of fishery resources such as lobsters and bottomfish.
- Integrate central Pacific pelagic and insular ecosystem monitoring with stock assessments.
- Develop ecosystem models to describe ecosystem structure and dynamics for pelagic and insular ecosystems.
- Conduct fishery dynamics research on the rapidly growing American Samoa longline fishery.
- Continue work on developing better methods for estimating the incidental take of protected species.
- Expand the surveys of the deepwater coral community through out the Pacific region, using archival instruments to characterize environment.
- Expand ECOPATH parameters beyond the FFS region.
- Continue work associated with identifying and understanding ecological links between deepslope and shallow ecosystems with a focus on habitat aspects, particularly for fishery and protected species.
- Conduct studies on deep slope foraging habitat ecology of monk seals, black coral, and juvenile snappers in the main Hawaiian Islands.

I.D. Identifying, restoring, and mapping of essential fish habitat (EFH)

- Continue studying the bank summit habitat ecology, specifically study seasonality and growth of algal meadows using archival technology.
- Continue the research on deep slope habitat ecology, specifically explore acoustics to assess deep slope species.

- Develop effective tools to rapidly characterize and map benthic habitats of coral reef ecosystems.
- Determine the spatial distributions, composition, extent and health of the benthic substrates.
- Determine and define the EFH and HAPC for the coral reef areas.
- Associate identified habitats with distributions of the biological components of the ecosystem, including fish, invertebrates, and algae.
- Determine depth or habitat-based boundaries to support MPAs and the WPRFMC Coral Reef Ecosystem FMP.
- Provide high-resolution *in-situ* data to assist NOS in ground-truthing remote sensing-based mapping data of shallow water areas.
- Examine changes over time of the distribution and health of selected habitats, particularly corals, algae, and sand.
- Develop a multi-platform ocean observing system capable of monitoring the key physical and biological parameters likely to affect coral reef ecosystem health.
- Examine the role of ocean circulation on transport, distribution, and accumulation of marine debris with the goal of significantly improving debris removal efficiency and source identification.
- Develop GIS applications for mapping the NWHI lobster and bottomfish habitat, as well as identifying inter-relationship of precious (gold) coral and Hawaiian monk seal habitat.

I.E. Impact of anthropogenic factors and environmental changes on fish populations

- Evaluate the effects of climate change of interannual, decadal, and centennial scales on fisheries and fish habitat.
- Examine associations between the recruitment of juvenile insular species and climatic and oceanographic variables in the Hawaiian Archipelago.
- Investigate the linkage between the dynamics of oceanic features, including eddies, fronts, and boundary currents, and the dynamics of highly migratory fishes (tunas and billfishes) in the central and western Pacific.
- Develop and utilize a combination of remotely sensed observations of winds (scatterometers), temperature (AVHRR), sea surface height (altimeters), and ocean color (SeaWiFS) to define regions of oceanic convergence and the likely accumulation of

marine debris, and then develop methods to track and interdict marine debris at sea before it damages coral reef ecosystems.

- Identify derelict fishing gear and its probable sources based on gear type, material of construction, and construction methods used.
- Assess the amount of and evaluate the impacts of marine debris present on the coral reefs of the U.S. Pacific Islands.
- Remove marine debris from coral reefs and beaches to prevent further damage to the coral reef ecosystem and to mitigate entanglement hazards to the animals within the ecosystem.
- Continue to develop a campaign that promotes public awareness and education of marine debris affecting the U.S. Pacific Islands, focusing on educating the commercial fishing and maritime industries regarding the damage to coral reef ecosystems caused by marine debris and on efforts to minimize future damage by reducing or eliminating the sources.

II. Conservation Engineering Research

Recent Accomplishments:

A total of 194 experimental longline sets were conducted under a Scientific Research Permit (#1303) in the Pacific during March-July 2002 to explore measures to reduce longline fishery bycatch and mortality of sea turtles. Deep daytime fishing trials with stealth (camouflaged) fishing gear targeting swordfish were conducted to evaluate the economic viability of the modifications to typical swordfish fishing methods. Deployment of electronic hook timers and time depth recorders to document when and where turtle bycatch occurred and tests on the effectiveness of hook size and type (e.g., large circle hooks) on catch were also components of the experiment.

Approximately 90 at-sea observers were trained in attachment of pop-off satellite archival tags (PATs) in order to determine the impact of sea turtle longline interactions, such as survivorship and movement patterns of sea turtles post-release.

Research Priorities, FY 2004-2009:

- Undertake studies to determine the best methods to increase survival of protected, prohibited, or sensitive species caught by longline and troll vessels.
- Determine ways to reduce incidental capture of sea turtles in longline fishing gear through various sensory physiology experiments on sea turtles and targeted fish species (e.g., swordfish and tuna) in order to determine mechanisms used to attract (and eventually deter) both fish and turtles to bite baited hooks.
- Determine effective fishing gear modifications for reducing longline interactions with sea turtles, including at-sea experiments with the commercial longline fleet.

III. Research on the fisheries

Recent Accomplishments:

The required social impact analysis (SIA) for the WPRFMC 's proposed 50 mile area closure around Guam for bottomfish vessels greater than 50 feet in length was completed to fulfill the requirements for the WPRFMC 's FMP amendment which would limit the bottomfishing activities of large vessels in the nearshore areas of Guam.

Recent analysis on the quantitative measurement of fishing capacity in the Western Pacific Region was presented to the 83rd SSC. The study covered capacity analysis for four major fisheries under the management of the Western Pacific Regional Fishery Management Council - 1) Northwestern Hawaiian Islands (NWHI) lobster fishery, 2) NWHI bottomfish fishery, 3) Hawaii Pelagic longline fishery, and 4) American Samoa Pelagic longline fishery. Preliminary results indicate that excess capacity existed in some fisheries, especially in NWHI lobster fishery and NWHI bottomfish fishery. However, the study also suggested that additional analysis was needed; excess capacity can result from other factors such as changes in regulations, reduced stock abundance, or fluctuation of oceanic environment.

A GAM analysis on the catches of Pacific blue marlin has been completed. The correction of a large array of logbook data from the Hawaii-based longline fishery to generate a "research quality" database will now permit additional analyses such as computing standardized CPUE series for blue marlin from March 1994 - June 2002 and comparing it to the official fishery statistics. The analysis shows that even with the well-organized procedures in place, relatively sophisticated analyses may still be necessary to improve data quality, even under virtually ideal circumstances for monitoring.

Interviews with more than 80 captains, owners, or crew of Hawaii-based longline vessels have been completed in support of ongoing baseline sociological studies. Interviews were unique, with a different set of questions depending on the interviewee's interests, concerns, knowledge, and role in the industry and provided information describing the background of longline participants, including how they came to be involved in the fishery, and their perceptions of the fishing lifestyle, fisheries management and its impacts, and the longline fishing community and industry.

Research Priorities, FY 2004-2009:

III.A. Social and economic research

- Develop automated analytical templates integrated with current fishery performance, cost, and price information for completing RFAs in an efficient and timely basis. Augment these templates to include the basic demographic information required to initiate preliminary SIAs.

- Continue to research and update intra-industry linkages and develop input-output relationships to describe and model the employment, income, and economic activity impacts of management actions being considered for each of the FMP fisheries and fishing communities.
- Develop methods to compare and assess the various management options including MPAs, ecosystem preserves, and other time-area closures in restoring fish stocks and increasing sustainable yields.
- Develop methods and models to assess the effects of various management options on the recreational and subsistence fisheries in the island areas.
- Research the social and economic ramifications of the various management options on the recreational and subsistence fisheries in the island areas.
- Study small-boats, charter-boat, and tournament anglers to elicit explicit non-market economic values for blue marlin using standard contingent valuation techniques.
- Resurvey the Hawaii-based domestic longline fleet to provide revised baseline data for conducting regulatory impact analyses on forthcoming regulations.
- Develop a long-term monitoring program to provide baseline economic and social data for use in making fisheries management decisions.
- Develop an Economic Data Collection program that will cover Fishing Club Members and Tournament Participants in Hawaii.
- Develop profiles of fishing ports and communities in Hawaii, Guam, American Samoa, and CNMI. On July 3, 2003, NMFS approved a proposed definition of MSFCMA fishing communities in Hawaii that defined each of the major inhabited islands as a fishing community for the purposes of MSFCMA. This follows earlier approval of the definition of Guam, American Samoa, and CNMI each as a fishing community. This research examines patterns of engagement in and dependency on various fisheries within these broadly-defined fishing communities.
- Examine the economic values and policy tradeoffs associated with conservation and protection of threatened and endangered sea turtles in the Pacific.

IV. Information Management Research

Recent Accomplishments:

The WPacFIN American Samoa integrated data management system has implemented a longline logbook processing system which now includes field sampling and size frequency collection data. The non-confidential data summaries are available online through the WPacFIN website.

WPacFIN completed the PIFSC contribution to the annual Fisheries of the US. Data summaries from Hawaii, Guam, American Samoa, and the Commonwealth of the Northern Marianas were produced in a newly revised format this year.

The PIFSC ESDIM data rescue project created to archive the vast amount of hard copy data holdings was recently completed. The project has “saved” previously archived data on electronic media for use in retrospective and historical studies. The data archived spanned from the late 1940's to the present and resulted in approximately 33 gigabytes of archived data. The project advances the PIFSC’s commitment to OMB’s Paperwork Reduction Act requirements.

In partnership with collaborating agencies, the NOAA Coral Reef Information System (CoRIS) was developed.

Research Priorities, FY 2004-2009:

- Implement an Oracle-based integrated system for storing and distributing, via the Internet, appropriate PIFSC data holdings, including fisheries dependent, research cruise, remote sensing, laboratory, and video data.
- Develop GIS technology for mapping and spatial analysis of fisheries, oceanographic, and habitat information
- Advance approaches of data fusion to combine fisheries data and assessment model outputs with environmental data from ship, satellite, and physical models.
- Implement ORACLE-based integrated system for storing and distributing via the internet all of the Honolulu Laboratory data holdings, including fisheries dependent, research cruise, remote sensing, laboratory, video data, etc.
- Automate quarterly and annual compilation of fisheries statistics and annual reports on FMP fisheries.
- Maintain and improve the web-based access to non-confidential data. Investigate new avenues for public access to data.
- Research, develop and implement electronic data reporting programs for all areas and technology for fisheries dependent information i.e. electronic logbooks, seafood dealer reporting systems, etc.
- Research and develop alternate data reporting instruments to fulfill the Paperwork reduction act requirements.

- Develop automated systems for integrating data sets with common fields (e.g., longline logbook and observer reports, NOAA research vessel cruise data, and satellite oceanographic remote sensing).
- Continue to improve data security and data quality practices.
- Enhance and improve the fisheries monitoring input and output programs of the island areas.
- Research and implement new or alternate ways of archiving data to fulfill the Paperwork Reduction Act requirements.